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JOURNAL OF EDUCATIONAL RESEARCH

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JOURNAL *of* EDUCATIONAL RESEARCH

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SUMMARY OF READING INVESTIGATIONS

(July 1, 1934 to June 30, 1935)

WILLIAM S. GRAY
University of Chicago

THIS article presents a brief summary of investigations relating to reading published between July 1, 1934 and June 30, 1935. It continues the series of summaries which appeared in this journal in February, 1933, April, 1934, and February, 1935 and in the *Elementary School Journal* from 1925 to 1932 inclusive. The summary that follows aims merely to acquaint the reader with the various types of studies published and the most important findings. A study of the contents of this article should be followed by a critical reading of the various reports in which the reader finds himself most interested.

A general survey and analysis of the studies reported during the year reveal at least three striking facts. The first is that the studies in general are superior to those of previous years in that they are better planned, more carefully controlled, and interpreted with greater discrimination. The second is that the number of studies published is distinctly greater than ever before, permitting of more rigorous selection. The third is that whereas the problems studied relate to many different phases of reading, a large majority of them are concerned with a relatively small number of problems such as diagnosis and remedial procedures, the development of efficient reading and study habits, the vocabulary load and the development of a meaning vocabulary, the reading interests of children and adults, the factors that contribute to the difficulty of reading materials, and the hygiene of reading. The statement should be added that a surprisingly large number of the studies are concerned with problems at the secondary, college and adult levels, thus continuing the trend which began vigorously but a few years ago.

Reading readiness and related problems.—The large number of failures in reading in the first grade was emphasized by Yageman (112) who cites opinions and the results of studies indicating that such failures are

due in part to the fact that reading is introduced before many children are sufficiently mature to learn to read readily. She urges further study of the social, emotional, intellectual and physical factors involved in learning to read and the development of better measures of reading readiness. Thomson (91) reports data which show that children who have attained a mental age of at least six before systematic training in reading is introduced like it better and progress more rapidly than younger children. Woolf (111) showed that whereas there is some relation between scores on mental tests and progress in learning to read, there are many other factors which must be considered, such as the language used in the home, in grouping children for purposes of instruction in reading.

A comparative study of ten beginning reading systems.—Cooper (14) made a comparative study of ten beginning reading systems with respect to underlying philosophies, essential equipment, manual suggestions, the vocabulary, the use of phonics, the general and special techniques used, and the provision for testing, diagnosis and remedial work. The findings showed more similarity than difference in the systems studied. The unique character of each system, according to the findings, rests largely in the special techniques used. Basically all harmonize with the recommendations of the National Committee on Reading. The present tendency is for authors to be guided in the choice of both reading material and method by the needs and interests of the child.

The vocabulary of primary readers.—The vocabularies of beginning books in reading continue to challenge consideration. Gross (47) reports the results of a comparative study of ten pre-primers which included a total of 393 different words, 238 of which appeared four or more times. She rightly emphasized the fact that the exclusive use of such a list in the early reading activities "would defeat the very purpose of beginning reading." Foran (30) examined the results of several recent investigations of primers and first readers in the light of the principles of word selection and distribution. He found that unimportant words often take the place of important ones, that the vocabulary used is often not based on children's experiences, and that words are introduced very rapidly with insufficient repetition to insure retention. Stone (88) studied the vocabularies of sixteen second readers and prepared a list of 1,276 different words found in three or more of them. He considers the list of value in preparing supplementary reading material and practice exercises, work-books, etc., for use in the second grade.

Methods of developing word recognition in beginning reading.—The results of a survey of present-day methods in developing word recognition were reported by Myers (75) who examined courses of study, teachers' manuals, and recent books and articles. He found that contextual clues and the use of phonics supplemented by seat work and activities at the reading table were most widely approved. Major emphasis was given to contextual clues; the general trend indicates "that phonics should be taught incidentally or in immediate relation to content." Hildreth (50) reported the results of an elaborate individual study in word recognition which led to the conclusion that an "artificial serial order presentation of words" is inadequate and resulted in the recommendation that learning to read "should begin with highly pleasurable concepts and experiences that promise full enjoyment to the child." The importance of much supplementary reading at the primer level to promote the mastery of essential vocabulary was advocated by Dolch (20) as a result of a study of the efficiency of primers in teaching word recognition. It was found also by Uzicker (98) that the kind of practice secured in the use of a typewriter by those learning to read has an appreciable effect on progress in recognizing words. No claim was made that this is the only way of providing the perceptual training essential.

Vocabulary problems at more advanced levels.—Vocabulary problems are as challenging in the more advanced grades as in the primary. Thorndike pointed out that the vocabulary burden is very heavy, as a rule, in juvenile books (93) and that by the time pupils leave the ninth grade, they should know from 10,000 to 25,000 word meanings (92). As one way of promoting vocabulary growth, he recommended the use of relatively simple materials in which the vocabulary is controlled and in which meanings can be derived largely from the context (92, 93). He also pointed out certain advantages of teaching words in isolation; for example, words needing emphasis can be taught directly, procedures which facilitate learning can be used in teaching, and important meanings can be stressed.

Specific attention was given during the year to vocabulary problems in the social sciences and mathematics. As a result of a study made by Leavell and Hollister (58) in the seventh and eighth grades, it was found that as many as 3,733 different words appearing in the social science materials used were not known by one or more of the pupils. It was believed by the investigators that this number was sufficiently large to "prevent the pupils from securing the larger thought of the printed page." The rate of vocabulary growth in American history was studied by Weede

and Gilbert (105) who found that the average increase was about 69 technical words per semester. At this rate, they estimated that it would require about seven semesters for pupils to acquire a vocabulary of 1,050 technical words which previous investigators had indicated were essential. A legitimate question that arises relates to the possibility of increasing the rate of vocabulary development. In partial answer to this question, Newburn (77) carried on a series of experiments which showed that vocabulary drill secures significant gains in meaning vocabulary as compared with no such drill. His findings showed also no measurable difference "in the results achieved by drill upon the meanings that appear in the daily assignment as compared with drill upon meanings which are logically related regardless of their appearance in the assignment." The potency of specific drill was further demonstrated by Dresher (21) who gave "special attention" to technical words as they appeared in the mathematics textbook used. These findings are supported by the results of previous studies and justify increased attention to new meanings and concepts in all content fields.

Selection of readers.—During recent years the California State Curricular Commission has adopted an analytical approach to the study of the relative merits of books under consideration for adoption. As characterized by Waterman and Melbo (102), the plan involves "(1) the development of a set of criteria by which the books may be judged; (2) the formulation of a score card based on the assignment of numerical values to the items of the criteria; (3) the completion of a series of studies, primarily objective in character, designed to secure data with respect to the relative merits of the books on all the criteria; and (4) the interpretation and the utilization of these data in rating the books on the score card." The investigators present a detailed analysis and scores for each of six sixth-grade readers. On the basis of the evidence secured, they concluded that the authors and publishers of reading textbook materials "have apparently agreed rather well on the general nature of a basic sixth-grade reading text. It must avoid being purely a literary reader or solely a work-type reader. It must attempt to provide some kind of balance of widely differing kinds of material which will be suitable for many purposes and appealing to many interests" (101; 102).

Nature of the psychological processes in reading.—It is gratifying to note that increased effort is being made to determine the nature of the higher mental processes involved in reading and their relationships. Dewey (19) gave a series of tests to determine if measures of the facts

secured through reading history also measured ability to do inferential thinking about the material read. The results when interpreted indicated clearly "the need for giving pupils more careful training in doing inferential thinking as they read." They also justified the conclusion that "we can no longer assume that, by making factual tests of reading, we have at the same time measured true understanding of what is read." Salisbury (83) secured evidence which showed that training in logical organization, as involved in outlining and summarizing, produces marked improvement in reading ability and in general thinking or reasoning ability.

Pickford (81) made an analysis of the mental processes of a "high level character involved in the continuous meaningful reading of twenty-one passages by eighteen subjects." He reported that attitudes, rhythm and attention are tendencies which direct the reading process. "Attitude is an orientation or mental set which determines the specific line of interpretation. Rhythm distributes the emphasis in a sequence. Attention makes interpretation take one line rather than another." Feelings and emotions were found to be highly important also. They either indicate whether "the apprehension is or is not harmonious, or they help to relieve the reader of the task of apprehension when it is felt to be impossible." There is urgent need for additional studies in this field to determine more fully the nature of the higher mental processes involved in reading and interpretation.

Effect of improvement in reading on general intelligence.—Two studies were reported which suggest somewhat different answers to the implied question. Hawthorne (48) made use of group language intelligence tests in grades five to twelve inclusive before and after remedial instruction in reading. The records did not reveal improvement in intelligence scores corresponding to the improvement in reading. Furthermore, there was a low correlation between initial retardation and the I. Q. and an insignificant relationship between I. Q. and the amount of improvement in reading. These results differ somewhat from those reported earlier. Scruggs (85) carried on a similar study among more than two hundred negro children in the fifth grade, using a battery of individual and group intelligence tests. His findings revealed a measurable change in the intelligence status of the pupils. He, therefore, concluded that definitely-planned remedial training "may produce changes in pupils which not only reflect themselves in reading tests, but also in the acquisition of facilities which are useful in many non-reading situations." Much empirical evidence has accumulated recently which supports this general conclusion.

The improvement of study habits involving reading.—During recent years increasing recognition has been given to the importance of efficient reading and study habits. Evidence supporting this trend was secured during the year by Campsen and Kronick (10) who found positive correlation between test scores in chemistry and achievement in reading in the case of 48 high school boys, by Broom (9) who secured clear evidence of "the importance of reading as a study tool" and by Mills, Eckert and Williams (70) who found that "scholastically superior pupils in high school possess different, and presumably better study habits than pupils of low achievement, notably with respect to those techniques involving a higher type of study morale, such as effort, curiosity and perseverance." It is not surpising in view of such evidence that the bibliography on study, much of which involves reading, has been increasing rapidly of late, as reported by Woodring and Flemming (109, 110).

Conflicting evidence concerning the value of training in study habits was reported. Mills and Eckert (69) provided as a unit in a "How to Study" course "lectures and discussions on the mechanics of reading, analysis of methods of deriving more meaning from the printed page, extensive vocabulary work and the use of a large number of reading selections as practice exercises in increasing speed and comprehension." Neither the experimental nor the control group improved in reading ability during a period of four months. This result would be very discouraging, if abundant evidence of the value of specific training was not available from other sources. For example, Leggitt (59) provided guidance in (1) becoming informed about a new book, (2) the use of a general reference book, (3) the reading of a newspaper, (4) interpreting a diagram or chart, a picture graph, or a table of statistics, (5) summarizing, and (6) outlining and secured about 50 percent increase in the initial status of the students during a period of eighteen weeks, the largest amount of gain occurring during the first six weeks. Furthermore, Salisbury (84) secured evidence that a definite period devoted to improvement in outlining both as "a thought-getting and a thought-giving device" brings "valuable dividends in improved general scholarship in content subjects, as well as in reading and reasoning."

The efficacy of certain study procedures was also considered. McClusky (65) studied "the influence of a preliminary skimming on a normal reading of a passage immediately following the skimming" and found that whereas the rate of reading was increased in a majority of cases, comprehension was not improved. In fact, it decreased more frequently than

increased. McClusky points out that the conclusions apply "primarily to subject matter for which the reader possesses a background of experience and general knowledge" and should be applied with great caution to other types of material.

Corey (15) compared the value in acquiring ideas of listening to lectures and reading. The results showed that immediate recall is better in the case of the latter and that superior students do relatively better in tests on their readings than on lectures. In the case of delayed recall, there seemed to be very little difference in the relative value of the two methods of acquiring ideas.

Literature and reading.—Various types of studies relating to literature and reading were reported during the year. With respect to the objectives of teaching literature, the Committee on Research of the National Council of Teachers of English (76) found that the following were emphasized most frequently in 156 courses of study produced since 1925: "(1) to extend the range of the pupil's understanding and interests through vicarious experience in reading, and (2) to develop the desire and standards of evaluation to continue reading under one's own direction. Somewhat inconsistent with the first two are the high place accorded to a knowledge of literary types in the senior high school and the decidedly limited recognition of current literature and standards for the reading of newspapers and magazines." Nevertheless, the use of magazines in high-school English classes is assuming considerable importance, as shown by Bessey (1) who reported the results of a survey of this field.

Some of the values of enjoyable reading of literature were emphasized by MacLatchy and Beavers (63) in a study at the sixth-grade level. A group of superior readers were freed from most of the guidance usually provided for the grade group and were aided in finding books on science, travel, art and biography "which they would enjoy as much as the story books they were reading during leisure hours" and were stimulated "to enlarge their reading experience." As a result of this form of guidance, the pupils not only read widely but made distinct improvement in both oral and silent reading, as measured by standardized tests.

In a study of existing levels of appreciation for humorous literature, among 400 high-school pupils, Wells (106) secured evidence of ability to appreciate various types. Among all the grades tested, "absurdity was the favorite, with slapstick second, satire third, and whimsy fourth." With respect to the influence of cultural levels on appreciation, it was found to make very little difference in taste for humorous literature at the

seventh-grade level, but its influence becomes increasingly apparent as pupils advance in age and grade. With respect to the influence of sex, it was found in general that "girls appear to like slapstick and absurdity less and satire and whimsy more than do boys." The study pointed to the conclusion that grade and school and social background "have more relation to tastes for humorous literature than do mental ability or social adjustment."

Contrary to the findings of earlier investigators, West and Caldwell (107) found "little or no agreement between students and teachers as to their preference for the literature covered in the various classes." Furthermore, the correlation between teachers' judgments of student preferences and the preferences as stated by the students was quite low. The implication of this finding is that "teachers should not place too much confidence in their opinions of student interests but should strive to secure the information by more objective methods."

The reading interests of children and adults.—Unusual interest was expressed during the year in the reading interests of children and adults. Engledow and Farr (26) made a survey of the interests of 1871 boys and girls in England from 11 to 15 years of age and found in general "no need for alarm about the type of fiction which the boys and girls are reading." In a study of gifted children which has been in progress for some years, Witty and Lehman (108) secured no evidence of a peak in reading interest at about the age of thirteen, as is oftentimes affirmed. They found also that gifted girls read more than gifted boys, although the latter read more magazines and newspapers than the former. In general, the sex differences corresponded with those for unselected children.

Interesting facts concerning the reading interests of college students were reported by Horton (51) who made a study of what they read in college papers. He found that the men were most interested in athletics and the women in "campus gossip." The "College Digest Section" was the most popular among both sexes and the editorial page the most neglected. In a study of the use made of seven college libraries, McDiarmid (67) found that 91 percent of it was for curricular use, thus indicating a surprisingly small amount of recreational reading. Hunter (52) found that the students in the Milwaukee State Teachers College read a somewhat selected group of general periodicals to the neglect of professional magazines. In a study among both pre-service and in-service teachers, Waples (100) secured evidence of "a conventional and insufficient awareness of social issues" which he considered very unfortunate in view of the

leadership which teachers should exert over their pupils. In comparing the pre-service and in-service groups, he found that the former did more substantial reading concerning social issues but that the latter took them more seriously.

The reading interests of adults received much deserved attention during the year. Briggs (7) made a preliminary report of a survey in progress in Missouri involving 7000 adults "to determine more accurately than hitherto the reading habits and interests of the adult elements in our population." Two community studies of reading were reported, one of Hinsdale, a suburb of Chicago, by Carnovsky (11) and the other of Woodside on Long Island by Kelley, Sealock and Devereaux (54). The records secured showed that an unusually small percentage of the adult population read books to any considerable extent. The reasons offered most frequently for the non-use of the library are that it "does not have the books one wants" and "does not have the latest books." Other reasons offered are that the library is "too far from home," "do not have time to read," or "do not care to read." The percentages of men and women who do not use the library are about the same. Those with elementary education only use the library least. As a means of promoting wider use of the library, Flexner and Edge (29) recommend "the development of a staff of librarians concerned with the problems of adult education, qualified to act as interpreters, whose guidance and assistance shall be easy and practical—an integral part of a whole staff organized to help the public to the books they want to read."

Factors influencing reading activities.—The factors influencing the reading activities of children and adults are as challenging as the nature of their reading interests. In a survey of the factors influencing pupils' reading of library books, Broening (8) found that the most popular titles were those "that teachers and librarians want boys and girls to read," that the reasons given by the pupils for liking specific books were "plot, easy reading, pictures, size and kind of type, verbal magic, cover, appearance of page," and that the specific means used to interest pupils were: discussing background; displaying books; permitting pupils to select books from the collection; recalling books by the same author; and setting up activities that call for the use of books.

The influence of photoplays on the amount and character of outside reading has been much debated of late. Through its Committee on Photoplay Appreciation (61) the National Council of Teachers of English conducted a controlled experiment in this field. The responses to an initial

questionnaire showed that about two-thirds of the pupils were able to name books which they had read as a result of seeing photoplays. This in the judgment of the committee indicates about "the normal or average influence of movies on the reading of children of high-school age in America today." Data secured later in the study showed "that the influence of books on the selection of movies is probably slightly greater than the influence of movies on the selection of books."

In a study of adult reading, Morriss, Morse and Phillips (74) proceeded on the assumption that simple books "with content of universal fundamental appeal" are essential in promoting the reading interests of adults of limited reading ability. In order to develop an appropriate reading list, detailed analyses were made of the simple books available and a classified list of titles was prepared. The study showed clearly that the number of simple books relating to various fields of interest is still too small to exert a strong influence on the reading habits of adults of limited education.

Factors influencing the readability of books.—Because of the urgent need for much simple reading material for use by adults as well as by children, various investigators have not attempted to determine the factors which contribute to its ease or difficulty. As a result of a detailed analysis of the vocabulary of juvenile books, Thorndike (93) concluded that the vocabulary burden of such books should be reduced. He (92) also emphasized the importance of an extension of the reading vocabularies of pupils in grades four to nine in particular in order to insure greater reading power.

Two elaborate studies of the factors that make a book readable were made with special reference to adults of limited reading ability. Dale and Tyler (17) determined the comprehension difficulty of a series of passages relating to health problems. He then correlated the indexes of difficulty for these passages with the presence in them of various factors of expression that might contribute to difficulty. Gray and Leary (44), using a similar technique, but more varied types of material, secured corresponding information. In addition, McClusky (66) reported the results of an analysis of some of the factors that contribute to the difficulty of passages in six books used at the college level. On the basis of all the evidence available, the following factors, among others, seem to be closely related to difficulty in comprehension: number of different hard words, number of prepositional phrases, number of different words, number of words not known to 90 percent of sixth-grade pupils, percentage of easy

words, and the average sentence length in words. Through the use of these findings, progress has been made in classifying available material on the basis of difficulty and in preparing new material for adults which is relatively easy to read. The fact is recognized, however, that many other factors contribute to difficulty. Of special importance in this connection is the nature of the concepts presented. It is obvious that the studies made thus far represent merely an initial attack upon a difficult but very important problem.

Remedial teaching at different levels.—The needs of poor readers are now recognized and provided for at various levels from the primary grades to the University. This section of the summary is concerned with reports of remedial procedures adopted at the elementary, secondary and college levels in improving reading habits. Evidence of the value of carefully-planned remedial teaching at the elementary level was presented in the reports of Gates (34), Lamoreaux, Farley, Herring and Trott (57), and MacLatchy and Beavers (63). Gates, for example, gave preliminary training to a group of teachers who had had very little experience in remedial teaching. The pupils taught were "non-readers" and were drawn entirely from grades two to four inclusive. Three programs of remedial teaching were adopted all of which emphasized word recognition. During a period of forty coaching days, an average gain of 4.8 months was secured.

Remedial work at the high-school level is organized in various ways. In some cities, the needs of poor readers are widely recognized and special classes are organized in which appropriate instruction is provided. For example, Gatto (35) reports the results of a remedial program in thirteen high schools of Pittsburgh in which use was made of factual material to "insure the utmost transfer to the work of regular classes." A second procedure is illustrated in the report of Persons (80) who described the initial survey of the reading achievement of all first-term pupils who reported for English in the Theodore Roosevelt High School, New York City. A period of three weeks was reserved in all Freshman English classes for intensive work in reading. The results indicated clearly that a definite and coördinated attack upon the reading problems of a large group has definite possibilities. A third plan depends largely on the initiative of individual teachers, usually in the English department, who recognize the reading needs of their pupils and provide remedial training as a part of their program of teaching. This plan is exemplified in the reports of Miller (68), Gibbs, (37), and Schuchowsky and Flemming (87).

A report by Gerberich (36) summarizing five years of experience with a remedial reading course for college students, supplies evidence of the value of such training. A new diagnostic technique for use at the college level has been developed by Ryder (82) which can be employed either with groups or individuals. The items in his Check List which refer to both reading and study habits are so worded that they may be used by the student in individual effort to improve his reading and study habits. Various methods which are commonly employed in remedial work among college students have been critically summarized by Strang (89), thus presenting in somewhat brief form a series of very helpful suggestions.

Summaries of diagnostic and remedial procedures. — The literature relating to diagnosis and remedial procedures has been summarized in various ways during the year. Monroe (71) prepared a very helpful report in which special emphasis was given to the causes of reading difficulty and to appropriate remedial procedures. Justak (53) summarized the most important facts and theories concerning special reading disability presented in 171 references, giving special consideration to symptoms, etiological explanations, and remedial treatment. Betts (4) presented abstracts of forty-three investigations relating to reading disabilities and their correction, and reported certain conclusions based upon them. When this report was presented to the National Conference on Research in Elementary School English, it was supplemented by critical reports from Durrell (22), Gates (33), and Gray (41). The content of these summaries supply striking evidence of the progress which has been made in the study of reading disabilities. They reveal also numerous conflicting views and theories and the urgent need for further intensive study of the more complex and subtle issues involved.

The non-reader.—The non-reader, or the child of normal intelligence who encounters unusual difficulty in reading, often presents a very baffling problem. However, Eames and Peabody (25) describe a case which supports their contention that "when existing physical, psychological and mechanical handicaps" are recognized and corrected and a systematic program of re-education adopted, improvement in reading follows. One possible cause of little or no progress in learning to read, according to Frank (31), is that "the mode of perception of the backward reader has remained on the same level as that of the young child." The methods used in developing habits of recognition have been summarized under three headings by Tinker (95): the alphabet method, advocated early by Hinshelwood, which involved spelling the words accompanied at times

by tracing; the kinaesthetic method, proposed by Fernald and Keller; the intrinsic method used by Gates in which "the instruction in phonetics, phrasing and the like is usually part of an actual reading situation." However, the Gates method "is really a visual study and writing (spelling) method of instruction." The more recent form of this method "is much like that of Fernald and Keller." The procedure adopted recently by Monroe "is based mainly on an effective drill in phonetics and a kinaesthetic technique similar to those cited above." According to Tinker, all of these techniques "have been employed with marked success in instructing non-readers." In general, one dominating principle underlies all of them: "The teaching, when effective, leads to habits of consecutive perception from left to right along the word and along the sentence, with strong emphasis upon developing adequate apprehension of words as wholes."

Relation of visual and auditory defects to reading disability. — The relation of physical factors and conditions to reading disability has been emphasized repeatedly of late, particularly by Betts (2). In a study of the visual defects of school entrants, he found that 86 percent evidenced normal fusion speed and power; about two-thirds of those studied had normal binocular acuity, or better; and at least one-third were more or less far-sighted. He reported also that the interpupillary distance increased most rapidly during the first-grade period. It is obvious that visual characteristics change with age and differ radically among children of the same age group. Betts recommends the postponement of beginning reading in the case of children whose visual development is retarded.

Crider (16) studied the relation of eye-muscle imbalance to reading habits and found when the eyes were tested separately that digits are usually read by the eye having "the most efficient muscalature." In a comparative study of eighty-eight reading disability cases and fifty-two cases chosen at random from grades two to four inclusive, Eames (23) found that "the median amplitude of fusion convergence was lower among non-readers than among unselected cases." Using college students as subjects, Blake and Dearborn (5) found that "there is a higher proportion of far-sightedness among those having difficulty in reading, and a higher proportion of near-sighted astigmatism among the good readers." In a study of 1,685 cases, Farris (27) found that 44 percent had eye defects of varying degrees. Some of the pupils with eye defects were good readers and some were poor readers. Providing lenses to correct hyperopia and strabismus proved to be an aid to achievement in reading. A study by Fendrick (28)

provided evidence of the greater frequency of astigmatic anomalies and of inferior performance on measures of visual acuity among poor readers. Although the studies reported do not agree fully concerning the relationship of various visual defects to reading disability, they show clearly that visual defects should not be neglected and that more intensive investigations are needed to determine the significance of each in respect to reading.

Only a limited number of studies have been reported thus far concerning the relation of auditory defects to reading. In a comparative study of good and poor readers, Bond (6) found that there was a significant difference between the two groups in auditory acuity, auditory discrimination, and auditory perception techniques. The data secured also led to the conclusion that if a pupil "is exposed to an oral-phonetic type of instruction, auditory ability appears to be a factor of importance in relation to reading disability." On the other hand, if pupils are taught "by predominantly look-and-say techniques, auditory factors do not maintain their dominant position as characterizing elements associated with inadequate reading performance."

Reversals and dominance.—The peak of interest concerning reversals in reading and dominance seems to be past. Only two studies in this general area were reported during the year. As a result of a study including 50 kindergarten and 120 first-grade children, Davidson (18) concluded that "it is a natural phenomenon for very young children to read words backwards and that they learn to perceive words as adults do as a result of increasing maturity and experience." She believes that if further investigation confirms her findings, "Orton's theory of the lack of cortical dominance will hardly be adequate to explain the reversal type of error." She points out, however, that reversals may be of different types and due to different causes.

Eames (24) found that lateral dominance anomalies are much more frequent among poor readers than among unselected children. As a result of a study of their anatomical basis, he concludes that reading difficulties arising from lateral dominance anomalies may be regarded as due to: "lengthened reflex ares"; "adventitious reflexes of an inhibitory nature"; "functional development of the visual memory center on the right side of the brain."

Reading disability among the mentally deficient.—Hegge (49) presents evidence that "mentally deficient special reading disability cases" can usually acquire satisfactory reading ability (approximately fourth grade). He advocated the postponement of reading for mentally retarded

pupils and argues that there will be no resulting loss in academic attainment. Kirk (56) also reports very satisfactory progress in reading (1.2 years in five months of training) in the case of ten high-grade mental defectives (I.Q.'s 75). Sears (86) found that the incidence of so-called "word blindness" among mentally defective cases of reading disability was very low, thus offering encouragement to those who are engaged in training mentally-retarded pupils to read.

Hygiene of reading.—Several interesting and significant studies relating to the hygiene of reading were published during the year. Taylor (90) secured evidence supporting "the general conclusion that black print on a white background is more legible than white on black." This was true whether she measured legibility in terms of "span of visual apprehension, speed of reading, recognizability in peripheral vision, or the greatest distance at which print could be read." Webster and Tinker carried on two series of studies. In the first (103), they determined by the distance method the relative legibility of ten type faces and found that the American Typewriter face was the best of those studied. Their findings differ significantly from previous studies in which legibility was measured in terms of speed of reading. In the second study, Webster and Tinker (104) measured the legibility of print on three paper surfaces, namely egg-shell, artisan enamel, and flint enamel paper stock. Their findings failed to disclose "any differential effect" during the short reading periods used. They concluded that the alleged eye strain resulting from reading print on glazed paper "must be due entirely to continuous reading in light not uniformly dispersed rather than to inability to see the print satisfactorily." Greene (45) compared the speed and accuracy of reading Ionic linotype and American typewritten material when 7 and 10 point type were used. The records revealed only slight differences, the linotyped samples being read slightly faster with 7 point type and slightly slower with 10 point type. Tinker (96, 97) summarized evidence from various sources concerning illumination intensities essential for reading. He found that for all but abnormal eyes and the reading of illegible print, "10 to 15 foot-candles furnish ample margin of safety in brightness of illumination." He found no evidence to support the assumption that "from 25 to several hundred foot-candles of artificial illumination" are essential "for easy and efficient reading of legible print." The refinement in the techniques used in studies in this field has been noteworthy during recent years with the result that the records secured have increased reliability.

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BETTS' PHYSIOLOGICAL APPROACH TO THE ANALYSIS OF READING DISABILITIES AS APPLIED TO THE COLLEGE LEVEL

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ACCORDING to recent experiments by Betts,[1] poor reading at the first grade level is frequently caused by visual refractive errors, or by certain anomalies of binocular coördination, or by both. Betts implies in this article that sensory deficiencies, either structural or functional, are one of the important causes of poor reading at later age levels.

The present study was conducted in the Reading Clinic for College Freshmen at the University of Iowa to determine whether such peripheral deficiencies, as revealed by Betts' tests, differentiate significantly between poor and good readers at the college freshman level. A secondary purpose of the study was to establish norms of performance on these tests at this age level. Such norms should be of value to reading clinicians who are using, or intending to use, these sensory tests.

The apparatus used in this study was the Keystone Ophthalmic Telebinocular,[2] which has been described in detail by Betts.[3] The tests were given by a trained reading clinician exactly according to directions. In this investigation 267 students were tested. These subjects were divided into three major groups and one minor group. All of the subjects in the major groups were selected from freshmen men who entered the University in the fall of 1934. Their coöperation was secured by summoning them to the Reading Clinic through the office of the Dean of Men.

The subjects were selected on the basis of their total comprehension scores on the *Iowa Silent Reading Test*. This test is primarily a measure of comprehension, but because each part has a time limit, rate of reading also affects the test score. In order to facilitate our discussion, we will use the term "reading ability" to refer to performance on the *Iowa Silent Reading Test*. The subjects were allocated to three major groups as follows:

[1] Betts, Emmett Albert. "A Physiological Approach to the Analysis of Reading Disabilities," *Educational Research Bulletin*, Columbus, Ohio: Ohio State University, XIII (1934), Nos. 6 and 7.

[2] This apparatus is distributed by the Keystone View Co., Meadville, Pa. It contains all equipment for giving the Betts visual tests, assembled in convenient form.

[3] Betts, Emmett Albert. Manual of Directions for Ready to Read Tests, Meadville, Pa. Keystone View Co., 1934.

1. *Unselected group.*—This group consisted of 94 subjects selected at random from the freshman class.
2. *Good readers.*—This group consisted of 63 subjects who upon admission to the University scored in the highest decile on the *Iowa Silent Reading Test.*
3. *Poor readers.*—This group consisted of 70 subjects who upon admission to the University scored in the lowest decile on the *Iowa Silent Reading Test.*

A fourth division, referred to as the minor group, contained 40 stutterers, ranging in age from 17 to 29, from the University of Iowa Speech Clinic. These speech defect cases were tested as an adjunct to the major investigation. Several studies have shown that stutterers exhibit muscular inadequacies in skills other than speech, notably in eye-movements while reading. It was felt that Betts' tests of binocular coördination might reveal some of these muscular inadequacies in stutterers, and, if so, would be an added tool for the speech clinician. Those reading this study who are interested only in poor reading as such may disregard the data included on this group of stutterers.

This experiment is both experimental and statistical. The experimental conditions in testing each subject were controlled as rigidly as possible in a clinical situation. After the testing had been completed, the general procedure was to compare the average scores on the various tests and sub-tests of Betts' battery made by a group of definitely superior and a group of definitely inferior readers. It seems reasonable to suppose that any test of the battery which is related to reading ability at this level should yield a different average score for good and poor readers. The other two groups considered in this study, that is the unselected readers and stutterers, were added for purposes of further comparison. The average scores of each of our four groups are also compared with Betts' first-grade entrants, as computed from his data.

The Betts tests were administered as part of a general program of analysis and treatment of reading deficiencies. All testing was done by one well-trained reading clinician in order to insure standard administration of the tests. If the subject wore glasses he was tested twice, first without and then with the correction. The purpose of testing subjects accustomed to wearing glasses both with and without their correction was to determine (1) whether there were any differences in the visual efficiency of the uncorrected eyes of the poor versus the good reader; and (2) to determine whether there were any differences between the groups when

all subjects were tested with the equipment which they normally use in reading (either eyes alone or eyes plus glasses). The data are summarized in terms of the percent of the total number in each group that gave a specific response. In some cases this response indicates defective vision and in some cases normal vision, depending on the test. In each table, column 1 contains the percent of responses for each variable when all subjects were tested without glasses, whether or not they usually wore glasses for reading. Likewise, in each table, column 2 contains the percent of responses for each variable when the subjects were tested with or without glasses, depending on whether they were normally accustomed to wearing a correction while reading. It is interesting to note that glasses were worn by 18 percent of the unselected group, 19 percent of the poor readers, 30 percent of the good readers, and 50 percent of the stutterers.

I. Comparison of Test Scores on Betts' Battery of Poor, Good and Unselected Readers at the College Freshman Level, Stutterers and First-Grade Entrants.—The data on the various sub-tests of Betts' battery will be summarized in the following order: (1) far-point and near-point fusion; (2) lateral muscle imbalance; (3) vertical muscle imbalance; (4) stereopsis level (depth perception); (5) visual acuity; and (6) ametropia, that is, errors of refraction such as hypermetropia (far-sightedness), myopia (near-sightedness), and astigmatism. The tables may be used as norms of performance on these tests at the college level.

1. *Far-point and near-point fusion.*—The results of the tests for far-point and near-point fusion are shown in Table I. The test for far-point fusion is designed to yield an indication of the individual's fusion ability at a distance of 40 inches; the test for near-point fusion measures fusion ability at reading distance (13 inches). Betts'[4] results revealed that 86 percent of 120 first-grade entrants evidenced normal fusion in both the far-point and the near-point tests. All of the groups in the present study experienced normal fusion much less frequently than did the younger subjects studied by Betts.[5] The highest incidence of normal fusion found in our study was 73 percent in the case of the unselected group (with correction). Even this value is 13 percent lower than the percentage reported

[4] Betts, E. A., *op. cit.*

[5] In comparing our results with those reported by Betts for first grade entrants, it should be remembered that we used slides DB4-33779 and DB5-33780 for testing far and near point fusion, respectively. These slides were revised by Betts and contain smaller balls than used in his earlier study.

TABLE I

SUMMARY OF DATA FOR FUSION OF UNIVERSITY FRESHMEN

Column (1) Percent of subjects (all tested without glasses) giving response indicated in sub-test column
Column (2) Percent of subjects (allowing those accustomed to glasses to use their correction) giving response indicated in sub-test column

Sub-tests	FAR POINT FUSION—(40 inches)								NEAR POINT FUSION—(13 inches)							
	Unselected group N = 94		Poor readers N = 70		Good readers N = 63		Stutterers N = 40		Unselected group N = 94		Poor readers N = 70		Good readers N = 63		Stutterers N = 40	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Monocular vision (no fusion (Fail-2)	4	4	3	3	2	2			2	2	3	3				
Suppression, then slow fusion (2 then 3)					2				1	1			2	2	3	
Gross binocular vision (no fusion) (Fail-4)	49	51	43	41	38	38	43	45	19	17	16	16	25	17	23	18
Slow fusion (Questionable) (4 then 3)	18	17	24	21	30	33	28	20	9	6	14	17	11	11	20	23
Normal fusion (Normal-3)	29	28	30	34	30	25	30	35	69	73	67	64	62	70	55	60

by Betts for first-grade children. In the present study only 35 percent or less of any group gave a normal response for far-point fusion, and only 73 percent or less of any group responded normally for near-point fusion. As seen from column 2 in Table I, the percentages of normal fusion in each of our major groups at far-point (with correction) were 28, 34 and 25 respectively, and 35 percent for the stutterers. The corresponding percentages listed in above rows in the table for the other sub-tests show correspondingly small differences among the groups. Similar figures are shown in the right hand side of the table for near-point fusion. There are no statistically significant differences in the various responses to the tests of near-point and far-point fusion among the four groups included in this study.

That the differences in near-point fusion among the groups of the present study are probably fortuitous is further shown by an analysis of eye-movements during silent reading. Records were available[6] for 71 subjects in the unselected group, for 36 of the poor readers and for 30 of the good readers. The eye-movements were photographed with the Iowa eye-movement camera during the hour that Betts' battery was administered. Since photographing necessitated reading without glasses the individuals with severe myopia were not included in the experiment.

Those who failed on the near-point fusion test did not make a significantly greater number of eye-fixations on the selection read than did those who had normal fusion. Neither was the average duration of fixation significantly larger in the case of the individuals exhibiting poor fusion. The mean number of fixations and the average duration of fixation for the various groups with normal and poor fusion on the test are shown below:

	Normal Near-Point Fusion			Failure in Near-Point Fusion		
	No. of Subjects	Ave. No. of Fixations	Ave. Duration of Fixation	No. of Subjects	Ave. No. of Fixations	Ave. Duration of Fixation
Unselected group	56	85.16	.275	15	85.53	.270
Poor readers	26	98.77	.286	10	100.70	.305
Good readers	20	72.40	.265	10	72.60	.290

[6] These data are used with the permission of I. H. Anderson, a reading clinician at the University of Iowa.

Biserial correlations between failure on the near point of fusion test (without correction) and number of fixations were extremely low in all of the groups as follows:

	N	*r*
Unselected group	71	− .01
Poor readers	36	+ .05
Good readers	30	+ .01

Biserial correlations between failure on the near-point fusion test and average duration of fixation were also low:

	N	*r*
Unselected group	71	− .10
Poor readers	36	+ .42
Good readers	30	+ .33

The largest coefficient .42 in the case of the poor readers is only 3.2 times its probable error and therefore is not statistically significant. While these results should not be considered as final, inasmuch as the number of subjects in the various groups studied is small, nevertheless they tend to support the general point of view that eye-movement characteristics are not related to peripheral characteristics of the eyes.

The tendency toward uniformity of response in fusion among the different groups is further supported by the results of Betts' tests of oculomotor and perception habits. The normal response for all except one of these tests should be the perception of two columns of words or numbers. When the subjects were tested without glasses 73 percent of the unselected group, 77 percent of the poor readers, 71 percent of the good readers, and 75 percent of the stutterers made normal responses. When the responses of all subjects were considered, with those accustomed to glasses being tested with their correction, the unselected group, the poor readers, the good readers, and the stutterers responded normally 74, 76, 71 and 86 percent of the time, respectively.

2. *Lateral imbalance.*—The data for the test of lateral imbalance are presented in Table II. The purpose of this test is to measure the tendency of the eyes to deviate outward or inward from normal convergence. The class interval units were obtained from the test. A response to one of the smaller numbers indicates a tendency of the eyes to turn inward, whereas a response to one of the larger numbers indicates an outward deviation. Readings were secured when the subjects looked at distances the equivalent of 40 inches and 13 inches. At a distance of 40 inches a response

TABLE II

Summary of Data for Test of Lateral Imbalance

Column (1) Percent of subjects (all tested without glasses) giving different lateral imbalance responses
Column (2) Percent of subjects (allowing those accustomed to glasses to use their correction) giving different lateral imbalance responses

Responses	1 DIOPTER (Equivalent of 40 inches)								3 DIOPTERS (Equivalent of 13 inches)							
	Unselected group N = 92		Poor readers N = 68		Good readers N = 63		Stutterers N = 40		Unselected group N = 92		Poor readers N = 68		Good readers N = 63		Stutterers N = 40	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
16–16.75	1	1														
15–15.75																
14–14.75																
13–13.75																
12–12.75	1	1														
11–11.75	1	1	1	1			3	3								
10–10.75			3	1												
9– 9.75	5	5	1	3	3	5	3	3								
8– 8.75	22	16	18	16	22	11	20	20	1	1						
7– 7.75	46	53	65	65	56	59	57	55	1	1	3	1	5		3	
6– 6.75	17	15	10	10	14	22	15	15	14	13	12	12	16	13	18	13
5– 5.75	3	4		1	3	3	3	5	24	21	34	37	16	14	25	28
4– 4.75	1	1	1						29	33	32	26	27	30	20	20
3– 3.75	1			1					23	25	10	15	32	38	28	33
2– 2.75									5	4	9	7	5	3	8	8
1– 1.75	1	1							1	1				2		
0– .75												1				
–1– –.25									1	1						
Mean	7.46	7.46	7.55	7.47	7.41	7.29	7.48	7.36	4.49	4.46	4.70	4.63	4.52	4.23	4.58	4.38

between 7 and 8 was given by 53, 65, 59 and 55 percent, respectively, of the unselected group, poor readers, good readers and stutterers. The responses at the other class intervals for the 40 and 13 inch settings are summarized in like manner. Extreme deviations are present in approximately equal amounts for the four groups.

Twenty-two percent of the subjects in the unselected group, 15 percent of the poor readers, 21 percent of the good readers and 15 percent of the stutterers (all tested without glasses) responded at near-point to numbers that were smaller than 3½ or larger than 6½. When those wearing glasses were tested with their correction, 21 percent of the unselected subjects, 15 percent of the poor readers, 22 percent of the good readers and 18 percent of the stutterers gave a response outside the above range of tolerance. A comparison of the means and the distributions shows that there are no significant differences in lateral imbalance among the groups in the present study.

A further comparison was made between our results and Betts' data on first-grade entrants. The average scores at 40 and 13 inches, respectively, as computed from his data, were 7.54 and 4.66. There are no significant differences between these values and the averages of any of the groups in our study.

3. *Vertical imbalance.* — The data for vertical imbalance which are summarized in Table III indicate that this muscular defect of the eyes as here tested is very uncommon in all of the groups. This test was devised to determine whether or not the eyes function in the same horizontal plane. Vertical imbalance was found in 3 percent of the unselected group, 1.4 percent of the poor readers, and 2 percent of the good readers. The one good reader, who made up the 2 percent having vertical imbalance, wore glasses which corrected his deficiency. The difficulty was not corrected in the case of four subjects so affected in the poor and random

TABLE III

SUMMARY OF TEST FOR VERTICAL IMBALANCE

Column (1) Percent of subjects (all tested without glasses) responding as indicated in left hand column
Column (2) Percent of subjects (allowing those accustomed to glasses to use their correction) responding as indicated in left hand column

Responses	Unselected group N = 94		Poor readers N = 70		Good readers N = 63		Stutterers N = 40	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Suppression			1.4	1.4				
Imbalance	3	3	1.4	1.4	2			
Normal balance	97	97	97	97	98	100	100	100

groups. One of the poor readers could not be tested because of suppression of vision in one eye. The stutterers in this study evidenced normal balance. Betts' results converted into percentages show suppression in one percent, vertical imbalance in 2 percent, and normal balance in 97 percent of his first-grade entrants. These results agree very closely with the data of the present study.

4. *Stereopsis (depth perception).*—Table IV contains a summary of the data for stereopsis or depth perception for the various groups. According to Betts[7] a high degree of binocular coördination is required to pass this test. He states that the normal response for mature individuals on his test should be 100 percent stereopsis. It should be remembered, however, that Betts' test may be passed with a 100 percent score by an individual having only 50 percent stereopsis. In this section our percentages will refer to scores on the test, not to the absolute amount of stereopsis. When all of the subjects were tested without glasses, 100 percent stereopsis was found in 79 percent of the good readers, 87 percent of both the poor readers and the unselected group, and 85 percent of the stutterers. These figures show that the good readers made a satisfactory 100 percent response somewhat less frequently than did any of the other groups. The average percentage of stereopsis of the good readers was also smaller than the average of any other group. Bearing in mind that this test is standardized at 40 inches, the smaller mean and less frequent normal re-

TABLE IV

SUMMARY OF DATA FOR STEREOPSIS LEVEL

Column (1) Percent of subjects (all tested without glasses) showing various percentages of stereopsis
Column (2) Percent of subjects (allowing those accustomed to glasses to use their correction) showing various percentages of stereopsis

Percentage of Stereopsis	Unselected group N = 94		Poor readers N = 70		Good readers N = 63		Stutterers N = 40	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
0	9	7	3	4	13	2	3	
10					2			
20					3	3		
30								
40								
50					2	2		
60	1	1	3	1		2	3	
70			1	1			8	3
80		1				2	3	
90	3	3	6	6	2	5		3
100	87	87	87	87	79	86	85	95
Mean	90.74	91.60	95.00	94.14	82.10	93.65	93.75	99.00

[7] Betts, E. A., *op. cit.*

TABLE V

Summary of Tests of Visual Acuity

Column (1) Percent of subjects (all tested without glasses) showing various percentages of visual acuity
Column (2) Percent of subjects (allowing those accustomed to glasses to use their correction) showing various percentages of visual acuity

Percentage of Acuity	Unselected group N=94						Poor readers N=70						Good readers N=63						Stutterers N=40					
	Binocular		Left		Right		Binocular		Left		Right		Binocular		Left		Right		Binocular		Left		Right	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
110	3	4																						
105	27	28	9	10	17	17	29	29	4	6	10	10	19	24	5	5	3	6	5	10			5	8
100	67	66	71	71	69	73	69	70	77	79	80	80	65	76	60	75	70	79	83	90	65	85	68	83
90	1	1	13	13	7	6			13	11	6	6	3		16	16	8	8	3		15	8	13	8
80			2	2	1							1	5		3	2	5	3	3		10	8	3	3
70					1	1					1		2		3			2	3		3			
60	1	1			1		3	1			1	1	2		3		5	2			5		8	
50			2	2					1	1									3					
40									1	1			3				2							
30													2		5		3						3	
20			1	1		1			1			1			5	3	3				3			
10																								
00	1		2	1	2				1	1	1						2		3				3	
Mean(1)	100.05		94.68		97.13		100.29		94.79		97.50		95.56		88.65		89.21		95.00		91.75		91.25	
Mean(2)	101.28		95.80		99.15		100.86		96.14		97.93		101.19		95.79		97.78		100.50		97.75		99.13	

sponse in the good readers may possibly be accounted for in part by the higher incidence of myopia in this group than among the poor readers and the unselected subjects. The differences among the means and the percentages of normal response for the various groups were practically negligible when those accustomed to glasses were tested with their correction.

On this test 63 percent of Betts' first-grade entrants showed a 100 percent score, the mean score (computed from his data) being 86.11 percent. This mean does not differ significantly from the mean of any group considered in this study. However, the fact that our good readers when tested without glasses gave a slightly lower mean, 82.1, than Betts' first-grade entrants would hardly support his contention that a high degree of the capacity measured by this test is essential for good reading.

5. *Visual acuity.*—A summary of the data for the tests of visual acuity is found in Table V. The data show that the good readers and the stutterers have somewhat poorer optical equipment when tested without glasses than do the poor readers and the unselected group. However, when the subjects were tested with their habitual corrections for visual defects, the differences in visual acuity among the various groups were negligible.

On this test Betts' first-grade entrants gave average scores (computed from his data) as follows: binocular 96.42; left eye 94.12; and right eye 93.99. These values agree very closely with the figures obtained on the groups in the present study.

6. *Ametropia (errors of refraction).*—Table VI presents the data for the various tests of ametropia. Betts'[8] data revealed that 86 out of 190 first-grade entrants (45 percent) showed varying amounts of hypermetropia (far-sightedness). In the present study 29 percent of the unselected group when tested without glasses showed evidence of hypermetropia in both eyes, in the right eye, or in the left eye alone.[9] When those who wore glasses were tested with their correction, 24 percent of the unselected group still exhibited varying amounts of far-sightedness.

[8] Betts, E. A., *op. cit.*

[9] The manual of instructions for the Ready to Read Tests states that the perception of three lines clearly in three or more balls is the criterion for hypermetropia. After our testing was completed Betts informed us in a personal communication that this is a misprint in the manual and that the criterion should be four balls. Accordingly we recomputed our data, and our Table VI is based upon the corrected criterion, namely, four balls.

It will be noticed that hypermetropia was found more frequently among the good readers than among the poor readers. Forty-five percent of the first-grade entrants tested by Betts were far-sighted. If he used four balls as the criterion, this indicates that hypermetropia is about 50 percent more frequent in first-grade entrants than in university freshmen. However, if he used three balls according to the instructions in the manual, there are no differences in this respect between his children and any of our groups.

TABLE VI

SUMMARY OF DATA FOR TESTS OF AMETROPIA

Column (1) Percent of subjects (all tested without glasses) testing as indicated in left hand column
Column (2) Percent of subjects (allowing those accustomed to glasses to use their correction) testing as indicated in left hand column

Tests	Eye or Eyes	Unselected group N = 94		Poor readers N = 70		Good readers N = 63		Stutterers N = 40	
		(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Hypermetropia	Both	16	14	6	4	14	13	10	3
Criterion: 3 lines seen clearly in 4 or more balls	Right	7	6	7	6	5	5	5	0
	Left	6	4	4	6	5	3	8	13
	Total	29	24	17	16	24	21	23	16
Myopia	Both	4	3	10	9	19	2	18	8
Criterion: Reading of above .50 diopters in 4 or more balls	Right	5	3	9	6	6	6	0	0
	Left	1	1	3	3	5	3	5	3
	Total	11	7	21	17	30	11	23	10
Astigmatism	Both	9	6	6	10	8	13	35	28
Criteria: (1) Failure to count 3 lines in any of the balls between .00 and 3.00 diopters; (2) reading of above .50 diopters if 3 lines are counted	Right	12	10	19	19	10	6	13	10
	Left	12	13	13	11	11	13	13	15
	Total	32	29	37	40	29	32	60	53

Myopia[10] occurred somewhat more frequently among the good readers (30 percent) than among the other groups when the subjects were tested without correction. Twenty-one percent of the poor readers, 11 percent of the unselected group and 23 percent of the stutterers were near-sighted. There were no significant differences among the percentages of myopia in the various groups when those accustomed to glasses were tested with their correction. In the latter results, however, myopia was slightly more common among the poor readers than among the other groups. Five percent of the first-grade entrants tested by Betts were near-sighted. Inspection of Table VI indicates that myopia is more prevalent among freshman men in college than among first-grade entrants.

[10] The criterion for myopia was a reading of above .50 diopters in 4 or more balls. This revision of the criterion given in the manual was used upon the recommendation of Betts.

Tendencies toward astigmatism[11] were exhibited more frequently by the poor readers (40 percent) than by the good readers (32 percent) when all subjects who wore a correction were tested with their glasses. The above difference cannot be considered statistically reliable, however, since the difference is only 1.43 times its probable error. Astigmatism was found less frequently in the unselected group (29 percent) than among the poor readers (40 percent) and the good readers (32 percent). Fifty-three percent of the stutterers showed evidence of astigmatism whereas astigmatism was present in only 29 percent of the unselected group. The above difference is large enough to be statistically significant. In the present study all of the groups except the stutterers showed evidence of astigmatism less frequently than did Betts' first-grade entrants, 55 percent of whom exhibited astigmatism.

II. Correlations of Tests in Betts' Battery with Reading Ability. 1. *Relationship between Betts' tests and reading ability.*—Our data were further analyzed to obtain a quantitative statement of the relationship between reading ability and scores on the tests of Betts' battery. The correlations to be discussed were obtained from a randomly selected group of 93 subjects. Biserial correlation coefficients between total comprehension scores on the *Iowa Silent Reading Test* and Betts' tests for astigmatism, hypermetropia, near-point fusion and lateral imbalance were all very low (ranging from + .12 to − .17). These biserial correlation coefficients are shown in Table VII. At the left are listed the correlations obtained when all subjects were tested without glasses. At the right are shown the correlations obtained when those accustomed to glasses were tested with their correction. The correlations are low and suggest that the responses on Betts' tests are not significantly related to reading ability. His tests for myopia, stereopsis and vertical imbalance were not included among the correlations because presence of these defects occurred so infrequently.

A criticism which may be made of this approach is that intelligence was not controlled. It was originally intended to use groups matched in intelligence, but differing in reading ability. However, the correlation between reading ability and general intelligence is so high (in our unselected group r = .90 between total comprehension scores on the *Iowa*

[11] The criteria for astigmatism were: (1) Failure to count three lines in any of the balls between .00 and 3.00 diopters; and (2) a reading of above .50 diopters in case three lines were reported as being seen. The first criterion was suggested by R. A. Sherman, manager of the Steropthalmic Division of the Keystone View Co.

TABLE VII

BISERIAL CORRELATIONS BETWEEN TESTS OF BETTS' BATTERY AND (1) TOTAL COMPREHENSION SCORES ON THE IOWA SILENT READING TEST AND (2) COMPOSITE SCORES ON THE UNIVERSITY QUALIFYING EXAMINATION AND PARTIAL CORRELATIONS BETWEEN READING ABILITY AND BETTS' TESTS WITH INTELLIGENCE HELD CONSTANT

N = 93 (Unselected group)	(1) (All subjects tested without glasses)			(2) (All subjects tested allowing those accustomed to glasses to wear their correction)		
Normal response on Betts' tests (absence of trait)	Reading r bis.	Intelligence r bis.	Reading partial r	Reading r bis.	Intelligence r bis.	Reading partial r
Astigmatism	+.01	−.01	+.04	+.12	+.10	+.07
Hypermetropia	+.03	−.004	+.08	−.002	−.03	+.06
Near-point fusion	−.02	+.07	+.10	−.01	+.09	+.16
Lateral imbalance (at near-point)	−.06	−.13	+.13	−.17	−.18	−.02
Whole battery*	−.10	−.06	−.11	−.06	−.01	−.12

*For the correlations under the heading "whole battery", a rough division of the subjects was made by placing those who failed on one or more tests in one group and those who passed all tests in the other group. In this division of the readers the tests for far-point fusion and lateral imbalance at far point were not considered for two reasons. First, preliminary analysis showed that such a large proportion of all subjects failed on the test of far-point fusion that practically no readers would have remained in the non-failing group had it been used in the division; and second, both these tests deal with distances greater than are used in ordinary reading.

Silent Reading Test and the *University Qualifying* composite scores) that, with a total of about only 500 freshmen available, it was impossible to obtain groups matched in this manner. We therefore decided to rule out intelligence statistically. The correlations mentioned in the preceding paragraph were recomputed holding intelligence constant by means of partial correlation. The results of these computations are shown in Table VII under the heading "Reading partial r." These values are all very low and indicate that even with intelligence ruled out the Betts' sensory tests are not appreciably related to reading ability at the college freshman level.

2. *Relationship between Betts' tests and report of eye-strain.* — A further possible service which Betts' tests may perform was investigated briefly. This is the relation between scores on this battery and tendencies toward eye-strain and fatigue.[12] Ninety-three randomly selected subjects were divided into two groups according to their answers to the question: "Are you subject to eye-strain?" This question was an item in the Bell Adjustment Inventory, a test given to all freshmen registering in the fall of 1934. Eye-strain was reported by 41 percent of the unselected subjects.

[12] The data reported in this paragraph were compiled at the suggestion of R. A. Sherman of the Keystone View Co., after the completion of the major work. The measure of eye-strain used was not entirely satisfactory, but was the only one available.

Forty-seven percent of the poor readers and 49 percent of the good readers, discussed previously, reported that they were subject to eye-strain.

Tetrachoric coefficients of correlation between eye-strain and scores on Betts' tests (with correction) were obtained for the 93 subjects. These correlations, shown in Table VIII, range from + .40 to − .22. The values are neither high nor statistically significant. It seems safe to conclude that there is little, if any, relationship between the scores on this battery and tendencies toward eye-strain as reported by the members of an unselected group. It is possible that the tests reveal tendencies toward eye-strain which are not recognized as such by the subjects. It is also conceivable that if the amount of eye-strain had been measured and only persons at the extremes in this variable had been considered, that a significant difference would have been found.

In our group of 70 poor readers the tetrachoric correlations between eye-strain and astigmatism and between eye-strain and ametropia (hypermetropia, myopia or astigmatism) were only .08 and .10, respectively.

III. Summary and Conclusions.—In summary, the data of the present study show that Betts' tests of visual sensation and perception do not differentiate significantly between poor and good readers at the college freshman level. The fact that the uncorrected eyes of the good reader are

TABLE VIII

Tetrachoric Correlations Between Eye-Strain and Betts' Tests in an Unselected Group of 93 Subjects

Betts' tests* (presence of trait)	Eye-strain r
Astigmatism**	+ .40
Hypermetropia	− .18
Near-point fusion	− .22
Lateral imbalance	+ .04
Whole battery (failure on any test except far-point fusion and imbalance at far-point)	+ .24

*The tests for myopia and stereopsis level were not correlated with eye-strain because failure on these tests occurred so infrequently. Seventy percent of the 10 subjects who had myopia (without correction) reported eye-strain and 86 percent of the 7 subjects who had myopia (with correction) reported eye-strain. Eighty-three percent of the 12 subjects who failed on the stereopsis test (without and with correction) reported eye-strain.

**The fact that eye-strain is more closely related to some visual defects than others and is perhaps most closely related to astigmatism is further shown by the percentages of students reporting eye-strain in each of the visual defect groups. These percentages are as follows: astigmatism, 62 percent; hypermetropia, 30 percent; failure on near-point fusion test, 29 percent; lateral imbalance at near-point, 42 percent; and failure on any test of the battery, 45 percent.

poorer in general, except in the case of astigmatism, than the uncorrected eyes of the poor reader, and the fact that the corrected eyes of both groups are approximately the same, make it seem improbable that differences in visual efficiency are causally related to differences in reading ability

among college students. The above conclusions are supported by an approach through statistical correlations in which it was found that Betts' tests are not appreciably related to reading ability. This statement is equally true whether intelligence is left uncontrolled or whether it is held constant by means of partial correlation.

In spite of the findings reported in this paper, the writers certainly do not wish to discourage a broad program of eye examination in the elementary schools. Betts' tests will undoubtedly shed light on occasional individual cases where a student is handicapped in reading by a visual defect. Furthermore, good vision is not only an advantage in reading, but is equally important in many other activities. Certainly Betts' battery will call attention to visual defects and furnishes a very convenient means for surveys and preliminary diagnoses. This alone justifies its use. We do wish to emphasize, however, that clinicians should be very slow in accepting test scores on this battery as indicative of the need for remedial treatment in reading. The battery should never be used as a drag-net test of reading ability at the college level. If this procedure were followed at this level, the remedial classes would be filled indiscriminately with good and poor readers. The reason for this is probably that sensory deficiencies are relatively unimportant as compared with central and more generalized habits and capacities. In view of the failure of this battery to differentiate among any of the major groups studied by the present writers, it is also recommended that persons using the battery at other age levels withhold final judgment on its validity as related to reading ability, until further comparative studies at various age levels have been made.

FACTORS ASSOCIATED WITH THE ETIOLOGY OF READING DISABILITY

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FOR several decades, there have been attempts, attended by varying degrees of success, to isolate the factors contributing to or causing ineffective silent reading. It was, of course, inevitable, after the discovery of the disparate nature of eye-movements in poor and in successful readers, that physiological factors should be investigated, and that devices for improving the movement of the eyes should be proferred as efficient remedial agents. There developed also extensive study of the visual apparatus and its condition in various degrees of reading skill. Although abundant data are available, the physiological processes involved in silent reading are still imperfectly understood, and many and varied are the explanations assigned to the visual-perceptual act in reading.

Much of the new knowledge applies to normal or efficient readers, and disability cases are still understood to a small degree only. To explain reading disability, many theories have been advanced and some have persisted (without adequate validation) for several decades.

Since 1925, a number of published accounts have emphasized the etiological relationship of two factors to reading disability. These factors, largely physiological in nature, are (1) vertical and lateral imbalance of the eye muscles (alleged to result in incoördinate binocular vision), and (2) mixed cerebral or mixed ocular and manual dominance (alleged to cause the reversals, faulty eye-movements, and other difficulties which characterize poor readers).

In 1935 a committee for The National Conference on Research in Elementary School English published abstracts of 24 studies containing suggestions for the analysis of reading disability. The problem of laterality was investigated by four members. Although the results of the studies are by no means conclusive, several investigators believe that there is little, if any, relationship between reversal errors and mixed hand-eye dominance, Gates (1), Woody and Phillips (2), Teegarden (3). Therefore, the significance of the factor of mixed eye-hand dominance in poor reading is naturally questioned despite the emphatic conclusions and assertions of Dearborn (4), Orton (5), and Monroe (6). And some investigators, with seemingly insufficient evidence, continue to emphasize the importance of lateral eye-muscle imbalance and fusion imperfections in read-

ing, Crider (7), Selzer (8), and Betts (9). Fendrick, in a recent study, reports data which make one skeptical of the relevancy of lateral muscle imbalance (10); however, difficulties in fusion are frequently reported in poor readers. Singular it is that one finds few investigations of the interest factor, although motivation and interest are occasionally mentioned, and one writer, Birdsall (11), states that good readers exceed poor readers in "purposefulness, technique, discrimination, and association."

The recent wide-spread interest in the Betts devices for measurement of eye condition, as well as the contradictory findings concerning laterality led the writers to study the rôles of vertical and lateral imbalances of the eye muscles and of mixed ocular and manual dominance in poor readers. In this paper, there will be presented only a part of the complete investigation. The relationship of poor reading to reversals, to fusion difficulties, to muscle imbalances, and to mixed eye-hand dominance will be set forth. In addition, the types of vision analysis recommended by Betts will be examined critically.

SELECTION OF SUBJECTS AND METHOD OF STUDY

One hundred public school pupils of I.Q. 80 or above were selected whose reading scores upon several standardized tests were the lowest among those of 2,000 children in grades 3-6 inclusive. The interests and play activities of these children were inventoried, their personality adjustment assayed, and they were given physical, mental, and reading examinations. A systematic and complete appraisal of the physiological functions underlying vision and hearing was made. The Betts tests of visual sensation and perception, and of oculomotor and perceptual habits—used in the Keystone Ophthalmic Telebinocular — were employed. Various phases of laterality were measured by informal tests, a modification of the Koch handedness questionnaire, the manoptoscope, audiometer, dynamometer, and other devices. The tests were given also to a control group of normal readers.

GENERAL DESCRIPTION OF GROUPS

Data concerning the two groups are presented in Table I. There are 66 boys and 34 girls in the problem group. Comparable numbers of boys and girls are in the control group, and the two groups contain proportionate numbers of children from the same grades and schools. The average I.Q. of the problem children is 96; of the control, 104. The average chronological age of the problem children is 10 years, 4 months; of the

control, 9 years, 2 months. Age-grade distributions show the problem children to be retarded 1 semester in 3 B; the retardation increases to 1 grade in 5 B.

Reading retardation of .87 grade in 3 B increased to 1.1 in 5 B, with the average retardation about one grade for the problem children. For the non-problem children, the average acceleration in reading was almost ½ grade. Thus, the disparity between the groups was approximately 1½ grades. These averages from the Metropolitan tests were corroborated by the Gates Silent Reading Tests. The reading ages of the problem children were consistently below their mental ages in the four grades; the average retardation was approximately 10 months. The reading achievement of the non-problems was in general consonant with mental age, although their achievement was slightly below mental age in grades 3 and 4, and slightly above in grades 5 and 6. Of interest, too, is the low arithmetic attainment of the reading problems.

RESULTS

The Betts Tests of Oculomotor and Perception Habits consist of a series of 10 slides standardized for grades 1, 2, and 3. Used were slides 22, 40, 41, 61, and 82. Slides 22, 61, and 82 contain (60) words which should be read successfully by a third grade child; slide 40 contains 28 letters, such as b, d, m, n, easily confused and reversed—which should be read successfully at a level *below* the third grade; similarly, slide 41 contains 20 numbers, recognition of which is expected in the first grade. In all, therefore, 108 symbols were presented to each child. The number of reversals for the problems decreased steadily from 9 in grade 3 B to 4 in 6 B; the average was 6.2. For the non-problem group, the incidence of 1 remained constant throughout the grades.

There was found also a continuous decrease in total errors (including reversals) in the Betts tests. The problem children made, on the average, 25 errors in grade 3 B, and 10 in 6 B. The non-problem exhibited an aver-

TABLE I

DESCRIPTION OF PROBLEMS AND NON-PROBLEMS

	N	Grade Placement	Average Age	Average I. Q.	Average Reading Achievement I	Average Reading Achievement II	Average Arith. Achievement	Average Number Errors	Average Number Reversals
1	2	3	4	5	6	7	8	9	10
Problem	100	3B-6B	10–4	96	−.96	−9.9	−.75	17.2	6.2
Non-Prob.	80	3B-6B	9–2	104	+.39	+1.1	−.51	2.4	1.1

age of 3 errors in 3 B and 1 in 5 B; for the group as a whole, the average was 2.4 errors. (See Table I.)

1. Problems: children one semester or more below their grade-norm in reading, on the Metropolitan Achievement Test.
   Non-problems: controls, matched for school, grade, sex—reading ability equivalent to or above grade-norms.
4. Age range—problems: 7-4 to 14-7; non-problems 7-4 to 12-4.
5. Kuhlman-Anderson Intelligence Tests.
   Range for problems: 80-116; for non-problems 83-123.
6. Figures, in *grades*, represent grade placement minus grade equivalent in reading (October, 1934).
7. Figures, in *months*, represent mental age minus reading age (October, 1934).
8. Figures, in *grades*, represent grade placement minus grade equivalent in arithmetic fundamentals (October, 1934).

9, 10. On the Betts tests of oculomotor and perception habits. (Figures in "9" include reversals.) The tests used—on 5 slides—contain a total of 108 words, letters and numbers which should be read successfully by a third grade child. Error and reversal scores thus represent roughly the percentage of errors and reversals, respectively.

TABLE II

HAND AND EYE PREFERENCES—PERCENTAGES

		R	R_L	A	L_R	L	Total	N
Hand	Problem	75	8	3	8	6	100	100
	Non-Problem	70	15	5	3	8	100	73
	All	72	11	4	6	7	100	173
Eye	Problem	52	8	5	5	30	100	100
	Non-Problem	54	13	3	9	22	101	78
	All	53	10	4	7	26	100	178

Hand: R = Right—86.4 percent to 100 percent, or 19 to 22 (of 22) items "right" on handedness questionnaire.

R_L = Right, with left-hand tendencies—63.7 percent to 81.8 percent, or 14 to 18 items "right."

A = Ambidextrous—45.5 percent to 59.1 percent, or 10 to 13 items "right."

L_R = Left, with right-hand tendencies—18.2 percent to 40.9 percent, or 4 to 9 items "right."

L = Left—0 percent to 13.7 percent, or 0 to 3 items "right."

Eye: Letters have same connotation as above. Degree of eyedness determined in similar fashion by consistency of monocular sighting with manoptoscope, paper hole, and finger-object.

TABLE III

LATERALITY RELATED TO REVERSALS

	Percentages of subjects					Average number of reversals made by				
	Right	Mixed	Left	Total	N	Right	Mixed	Left	Total	N
Problem	52	43	5	100	100	6.2	5.9	8.4	6.2	97
Non-Problem	56	40	4	100	71	1.3	0.9	0.0	1.1	70

Of the 25 possible combinations of handedness and eyedness under the method described above the following were considered "Right": R–R, R–R_L, R_L–R, R_L–R_L. The following were considered "Left": L–L, L–L_R, L_R–L, L–L. Included in the "mixed" group are all other combinations.

For explanation of reversal scores see Table I, note "9, 10."

TABLE IV

VISION RELATED TO READING ACHIEVEMENT

	Categories of vision	Problems Reading Achievement			Non-Problems Reading Achievement			P: N-p Percentages of N	
		N	Deviations*	Average deviations*	N	Deviations*	Average deviations*		
	Slow fusion:								
1a	Far distance	15	−2.057	−.1371	1	−.3083	−.3083		
1b	Near distance	12	2.705	.2254					
1c	Both far and near	2	.165	.0825					
1	Total slow fusion	29	.813	.0280	1	−.3083	−.3083	29	1
2	No fusion	18	2.062	.1145	15	2.8101	.1873	18	20
3	Lateral muscle imbalance (with fusion)	8	.140	.0175	12	−1.0555	−.0880	8	15
4 (1,2,3)	All fusion and muscle balance difficulties	55	3.015	.0548	28	1.4462	.0517	55	35
4a	All fusion and muscle balance difficulties with deficient acuity and ametropia	25	2.435	.097	14	1.176	.084	25	18
5	Deficient acuity and ametropia (only)	3	−1.961	−.6537	3	.4224	.0845	3	6
6	Deficient acuity (only)	3	−.796	−.2653				3	
7	Ametropia (only)	15	.157	.0105	15	−2.1598	−.1434	15	19
8 (5,6,7)	All: deficient acuity and ametropia	21	−2.609	−.1238	20	−1.7282	−.0864	21	25
9 (4,8)	All visual difficulties	76	.415	.0055	48	−.2820	−.0059	76	60
10	No visual difficulties	24	−.432	−.018	32	.2954	.0092	24	40

*Figures are plus when not preceded by minus signs.

MIXED DOMINANCE AND REVERSALS

Table II shows that poor readers tend to make many reversals. In this respect, the data corroborate Dearborn's work (12). The cause of this reading difficulty is unknown; however, several hypotheses have been advanced. For example, Dearborn (13), Orton (14), and others insist that

reversals are associated with and caused by mixed ocular-manual dominance. It will be pertinent, therefore, to examine the data for the problem cases to ascertain whether reversal tendencies predominate in the children displaying mixed dominance. Degree of eyedness was determined by the consistency of monocular sighting with the manoptoscope, the paper hole, and the finger-object methods. Handedness was determined by use of a reliable and valid form devised from the Koch questionnaire. About 70 percent of both groups prefer the right hand; about 7 percent, the left. Only about 4 percent are ambidextrous (Table II). More than 50 percent of both groups prefer the right eye; about 25 percent, the left eye. By reference to Table III, one may see that 43 percent of the problems and 40 percent of the non-problems display mixed dominance; only 5 percent of the problems and 4 percent of the non-problems are consistent in left ocular and manual behavior. In Table III are given also the number of reversals for the dominant right, dominant left, and mixed types of children. Significant is the fact that reversals occur with slightly smaller frequency in the mixed group than in the dominant right or dominant left groups. Further inspection of the table discloses the fact that those of a mixed dominance in the non-problem group exhibit no greater tendency to make reversals than do those not displaying this irregularity. The data at this point clearly support those of Gates (15), Woody and Phillips (16), and Teegarden (17), showing that there is little, if any, relationship between reversal errors and mixed eye-hand dominance.

Now the question logically arises: What are the relationships of certain eye conditions (emphasized by Betts) to poor and to effective reading. In attempting to ascertain the relationship of each ocular item to reading ability, the writers found it necessary to define degrees of reading ability as well as deviations in reading skill. The reader will recall, doubtless, that reading achievement was first reported (in Table I) by comparing reading grade equivalent with grade placement. All problem cases—by selection—were below their grade-norms; all non-problems had scores equivalent to or above their grade-norms. The average retardation of the problems and the average acceleration of the non-problems were computed by grade; thus, the average deviation of each grade was established. Deviations above (plus) and below (minus) the *grade* averages were then computed for each case, thus eliminating the effect of grade differences in level of reading ability, and making achievement comparable for each member of each group.

The visual classification in Table IV corresponds roughly to the functions measured by the Betts Tests of Visual Sensation and Perception. The effect of visual status upon reading achievement was studied by comparing the averages of the problem and non-problem children upon each grouping in the table.

The eye condition and the reading attainment of the problem and of the non-problem group will first be discussed; then comparisons of the two groups will be set forth.

FUSION DIFFICULTIES, LATERAL IMBALANCE, AND READING ATTAINMENT

Problems. — In the slow fusion group (problems), those with slow fusion at far distance only (group 1a) have an average deviation of −.14 grade. Those suffering with slow fusion at near, or reading distance (group 1b)—a condition ostensibly prejudicial to good reading—have an average plus deviation of .23 grade. The two cases with far and near slow fusion (group 1c) are above the average (of the problem class), while the combined cases (group 1) also are slightly above the average— + .08 grade.

No fusion, a condition asserted by Selzer (8), Eames (18), and Betts (9), to be a cause of reading disability, failed apparently to produce its alleged effect: group 2 is .11 grade above the average.

Combining all children having fusion and muscle balance difficulties in group 4, which contains 55 percent of the cases, and considering their educational status, one obtains for the group a slight positive deviation of .06 grade.

Included in group 4 are a considerable number of cases suffering not only from fusional and muscle balance difficulties, but also from deficient acuity and ametropia (group 4a). In the problem group 25 percent (and in the non-problem class, 18 percent) of the cases are doubly "afflicted." The average deviation, however, is + .10 grade.

Group 3, with lateral muscle imbalance—which is said to cause lack of fusion, Selzer (8), Eames (18), Crider (7)—is .02 grade above the average. Fendrick similarly found that lateral muscle imbalance does not contribute to reading disability, thus corroborating this finding (10).

Only three cases of deficient acuity and ametropia (group 5) and three of deficient acuity (group 6) show rather marked negative deviations. When these cases are combined with group 6 (ametropia only)—where there is a very slight positive deviation—the result is a negative deviation of .12 grade (group 8). Although this is one of the largest deviations

found, it is so small that it can scarcely be said to indicate the presence of a general factor contributing to poor reading. Monroe, corroborating this, reported that deficient visual acuity did not characterize her poor reading group (6).

All cases having visual difficulties (group 9) yield an average deviation of + .006 grade; all subjects exhibiting no visual difficulties (group 10) show an average deviation of − .02 grade. In none of the main groupings, then, does one find any significant reading deviation associated with a visual aberration or difficulty; in none is the average deviation more than a few hundredths of a grade above or below the average of the whole group.

Non-problems.—The one case of slow fusion (at far distance only) deviates minus .31 grade. The no-fusion group deviates .19 grade above the average. (This approximates the + .11 of the problem group.) The lateral muscle imbalance group is .09 below the average. (This corresponds closely to the + .02 grade deviation of the problem group.) The composite of these groups (group 4) is .05 grades above the average. Group 4a, containing cases with various combinations of every visual defect, resembles the problem group: a positive deviation of .08 grade corresponds closely to the problem group's average of + .10 grade.

Group 8—all cases of deficient acuity and ametropia—has an average deviation of − .09 (similar to the − .12 for the problem children).

Although the problem and non-problem group deviations reported above are similar in quantity (and direction), the difference in numbers in the problem and non-problem groups, and the minuteness of the deviations, have effected in the combinations in groups 9 and 10—all cases with and without visual difficulties, respectively—a reversal of plus and minus signs. The quantities, however, remain distinctly similar. Thus, in non-problem group 9, the average deviation is − .006; in the problem group, it is + .006. In non-problem group 10, it is + .009; in the problem group, − .018.

Thus again (in the control group) one finds no significant deviations. Differences in reading associated with various visual conditions measurable only in *hundredths* and *thousandths* of a grade cannot be deemed of importance.

Comparison of Problems and Non-Problems.—Several differences between the problem and non-problem class are of interest. Striking is the fact that 29 percent of the former and only 1 percent of the latter exhibit slow fusion. The reason for the disparity is not known. That this factor

is important etiologically (in the case of the poor readers) is doubtful, in light of the data reported herein.

The size advantage of the problem class in group 4—55 percent in comparison with 35 percent—is due, of course, to the heavy weighting of the slow fusion group.

Group 8 contains cases of deficient acuity and ametropia, uncomplicated by other difficulties. Adding to this group the cases included in group 4a, a percentage of 46 is obtained for the problem class, and 43 for the non-problem class. The similarity is noteworthy. Although the larger percentage of problem cases in group 4a may appear suggestive of a significant difference, a detailed analysis of "serious" cases in both problem and non-problem groups (not shown in Table IV) reveals that fully half of these cases have marked deviations *above* the average.

The similarity in percentages of cases with deficient acuity and ametropia (21 and 25, and 46 and 43, for problems and non-problems, respectively) has been noted. In group 9 (all visual difficulties) the difference between the 76 percent for the problems and the 60 percent for the non-problems is attributable largely to the preponderance of slow fusion cases in the former classification.

Interpretation.—Analysis of the data leads to the conclusion that the poor readers are not characterized by a higher incidence of visual defects and anomalies than are good readers. With the exception of the slow fusion group, the percentages among the non-problems are somewhat *higher* than among the problem children in practically all other visual (defect) categories studied. Furthermore, the effect of the various visual factors—slow fusion, no fusion, lateral muscle imbalance, deficient acuity, and ametropia, singly and in combination—appears negligible.

Are visual defects, then, unrelated to reading achievement? The answer, predicated upon the group analyses above, is not an unequivocal "yes." True it is, that the visual defects studied do not appear to cause or to contribute to reading disability. Further research is essential to determine those visual defects that most directly affect reading achievement. Nevertheless, before asserting that visual defects are not etiologically concerned in poor reading, one should recognize this alternative: visual defects may impede the reading process of both poor and "good" readers.[1]

[1] This conclusion is borne out by the report of research in reading difficulties reported by Dr. Gates on pages 83-91 of "The Applications of Research Findings to Current Educational Practices," Official Report of the American Educational Research Association, 1935.

In other words, it is suggested that although the relative incidence of various visual defects among poor readers does not distinguish them from good readers, visual defects are not unrelated to reading achievement: *correction of defects may improve the reading ability of poor readers and of readers who exhibit no (reading) difficulties.* Studies of individual cases with *marked* visual defects which have been corrected or ameliorated sometimes show definite improvement in reading attainment.

In support of the hypothesis that has been advanced one more point may be made. Although large percentages of visual defects are found both in poor and in good readers, one should realize that individuals vary greatly in their capacity to make successful adaptations and to compensate for defects. (Not only in psychoanalytic literature does one find instances of successful and adequate compensation for definite somatic and psychic inferiorities. Opthalmologists are fairly well agreed that fusion, for example, is dependent upon more than—and can occur without—ocular muscle balance. Essential is "a mental desire for a single image.") This is not, however, a suggestion that differentiation between the groups should be made on the basis of the effectiveness of an hypothesized compensatory function (if a satisfactory criterion for this could be found).

One must guard against over-simplification. To dismiss summarily further consideration of the effect of the visual-perceptual act upon efficient reading performance is to overlook the complexity of the process, its many-sided relationships to tonus of the neuro-musculature and to general physical and mental condition. One must bear in mind, too, not only the somewhat doubtful validity and reliability of the Betts tests (and of all eye-muscle tests) but also the lack of adequate standardization for many items contained in the Betts battery.

In conclusion, the etiology of reading disability (as an entity) lies in no single visual (or other noumenal) factor. Every item studied seems to be a symptom rather than a cause of the difficulty. Nevertheless, certain physiological factors, obviously accompanying reading disability, but not as yet found by group analyses to differentiate poor from good readers should receive attention in the *individual diagnosis* which should precede effective remedial endeavor.

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RESTRICTIONS OF THE VISUAL FIELD AS HANDICAPS TO LEARNING

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RESTRICTIONS of the visual fields limit the physical size of retinal images that can produce visual responses. If the retinal images are of lines or columns it follows that field restriction limits the amount of line or column that can be seen at a single fixation and hence restriction of the visual field may produce restriction of the recognition span.

At the exact center of the posterior part of the retina and in the axis of the eye-ball is the small area of most distinct or central vision; the fovea centralis,[1] which is from 0.3 to 0.4 millimeter in diameter.[2] The fovea is capable of initiating mental impressions of objects and their parts to the extent of one degree, thirty minutes, but larger objects require either extra foveal observation or more than one fixation so that the images of the parts of the object may be focused successively on the fovea for inspection. According to Howell,[3] " . . . In all close work . . . we keep our eyes moving continuously so as to bring one point after another into the center of the fovea . . . "

The average fovea is physically incapable of responding to a greater stretch of line or column than will subtend an angle of one degree, thirty minutes,[4] which at the usual reading distance of thirteen inches equals 0.3 of an inch. In ordinary textbook type there are few words that fall within this space and therefore it would appear that the eyes must make more than one fixation in order to afford perception and recognition of the longer words. It is commonly known that rapid readers make fewer than one fixation for every 0.3 inch and the explanation lies in the fact that extra foveal vision has been brought into play.[5]

There is a progressive diminution in visual acuity from the fovea to the periphery of the retina.[6] When a person looks at a long word, a line

[1] Lewis, W. H. *Gray's Anatomy*, 20th Edition (Philadelphia: Lea & Febiger, 1918), 1015 pp.
[2] Howell, W. H. *Text Book of Physiology* (Philadelphia: Saunders, 1931), 344 pp.
[3] Howell, W. H. *Text Book of Physiology* (Philadelphia: Saunders, 1931), 346 pp.
[4] Howell, W. H. *Text Book of Physiology* (Philadelphia: Saunders, 1931), 344 pp.
[5] Lloyd, Ralph I. *Visual Field Studies* (New York: Technical Press, 1926), 16 pp.
[6] Howell, W. H. *Text Book of Physiology* (Philadelphia: Saunders, 1931), pp. 345-346.

or column of letters or figures a small part of the retinal image falls on the fovea, resulting in a clear mental picture of the corresponding part of the line or column. The acuteness with which the retinal cells in the extra foveal area respond diminishes from the fovea outward in all directions, and I believe that the amount of line or column that can be recognized at a single fixation depends on the extent of actively functioning retinal tissue capable of sending to the brain neural impulses of sufficient intensity to produce impressions approaching but less than those of foveal vision, yet sufficiently above the threshold to permit recognition. The broader the extent of active peripheral tissue capable of producing this response the more can be taken in at a single fixation and fewer fixations will have to be made per line or column.

Following lines[7] involves the horizontal diameter of the retina which passes through the fovea, while the vertical diameter passing through the same point is used in following columns. When the extent of extra foveal vision is measured in a number of diameters and is charted the result is an ellipse-like figure representing the limits of the field of vision in the tested eye. In the present study this was done by means of a campimeter which I believe is the instrument of choice. Standard technique was employed. The field of each eye was measured for black and white, these being the colors of page and print as well as of blackboard and chalk. Since black and white are not really colors the field mentioned above might be termed an achromatic field. True color fields are of importance in the diagnosis of certain primary diseases and toxic conditions which would be disclosed by eye or physical examination. They were not included in this study for this reason and also because of the improbability of any important relationship between them and such educational processes as reading, spelling, arithmetic and writing, all of which are carried on with black and white materials in the great majority of cases.

All eye examinations including field measurements were made by the author and most of the general physical examinations were carried out by either Dr. Harold P. Freeman or Dr. G. Stanley Miles. Eighty-five educational disability cases were compared with forty unselected and twelve "Normal" cases, the latter being without educational, eye, or general physical troubles. The establishment of the "Normal" group is attended with great difficulty as many complete examinations must be made and the candidates rejected before a suitable individual is located. This

[7] Lloyd, Ralph I. *Visual Field Studies* (New York: Technical Press, 1926), 198 pp.

work is still in progress and further additions are to be made as suitable cases are discovered.

AGE AND GRADE RANGES AND MEDIANS

	Educational Disability Group	Unselected Group	"Normal" Group
Number of Cases	85	40	12
Age Range	6-4 to 19-1	5-1 to 18-9	3-8 to 13-2
Median Age	9-8	10-8	10-1
Grade Range	Ungraded to XI	Kindergarten to XII	Kindergarten to VIII
Median Grade	3.6	5.9	4.5

The fields were charted by measuring in degrees their extent in four principal diameters. (8 radii.) Composite fields were established for each eye in all groups by averaging all the measurements of each of the various diameters. For educational purposes the horizontal and vertical diameters are important in their relation to line and column work respectively. The oblique diameters are of little importance educationally but they are of definite value in physical diagnosis.

Table I presents the differences between the educational disability cases and the other two groups in terms of degrees of diameter, while Table II presents it in terms of degrees of radius. Table I reveals consistently smaller horizontal and vertical diameters among the educational disability cases as compared with the "Normal" and unselected groups.

TABLE I[1]

DIFFERENCES BETWEEN THE EDUCATIONAL DISABILITY CASES AND THE UNSELECTED AND "NORMAL" GROUPS IN TERMS OF DEGREES OF DIAMETER OF THE VISUAL FIELDS

Diameters	Difference between Educational Disability and Unselected Groups		Difference between Educational Disability and "Normal" Groups	
	Left eyes	Right eyes	Left eyes	Right eyes
Horisontal	16.4	4.2	18.4	6.4
Vertical	5.7	4.1	11.0	7.1
Oblique 1.	−2.9	3.9	4.2	7.7
Oblique 2.	−0.4	4.3	4.8	7.7

(Oblique 1 corresponds to the lower lateral to upper medial diameter of the retina and the visual field. Oblique 2 corresponds to the lower medial to upper lateral diameter.)

[1] The minus sign before a figure in any of the tables indicates that the educational disability group presents the larger dimension. When there is no sign the dimension in the educational disability group is the smaller.

TABLE II

SAME AS TABLE I BUT IN TERMS OF DEGREES OF RADIUS

Diameters	Difference between Educational Disability and Unselected Groups		Difference between Educational Disability and "Normal" Groups	
Vertical 1	1.4	1.9	4.0	3.2
Vertical 2	4.3	2.2	7.0	3.9
Horizontal 1	9.8	1.5	9.1	1.2
Horizontal 2	6.6	2.7	9.3	5.2

Horizontal 1 corresponds to the medial horizontal radius of the retina and the lateral horizontal radius of the field.
Horizontal 2 corresponds to the lateral horizontal radius of the retina and the medial horizontal radius of the field.
Vertical 1 corresponds to the lower vertical radius of the retina and the upper vertical radius of the field.
Vertical 2 corresponds to the upper vertical radius of the retina and the lower vertical radius of the field.

Table II shows the same condition. In both tables the tendency for the unselected to present larger fields than the educational disability group is evident as is also the tendency for the fields of the "Normal" group to be greater than either. The left eye presents greater differences in the horizontal and vertical diameters than the right eye but this tendency is less marked when the radii are considered.

The data was analysed in relation to lateral dominance and the unselected and educational disability groups were compared. Table III presents the difference in terms of degrees of horizontal and vertical diameter. The tendency for these diameters to be smaller in the educational disability group appears again in the right eyed-left handed class and to a lesser extent among the ambi-eyed. The tendency is *reversed* in the left eyed-right handed class.

Twenty-six of the educational disability cases were rechecked after periods of treatment averaging 4.76 months. The chief complaints in these cases were:

Poor reading	20
Poor reading and spelling	1
Poor reading and writing	1
Generally poor school work	4

At the close of the first examination treatment was prescribed for the physical handicaps disclosed in each case. Table IV presents the average increments in the visual fields noted on re-examination. There was an average increment for the group for each eye. The average increments were greater in the non-dominant eye. Improvement in school work as reported by teachers occurred as follows:

	Improvement	No improvement	No report
Poor readers	15	2	3
Poor reading and spelling	1	0	0
Poor reading and writing	0	1	0
Generally poor school work	3	0	1

TABLE III

LATERAL DOMINANCE CLASSIFICATIONS

Differences between Unselected and Educational Disability Groups in Terms of Degrees of Diameter

Lateral Dominance	Differences between unselected and Educational Disability Groups			
	Horizontal Diameter		Vertical Diameter	
	Left Eye	Right Eye	Left Eye	Right Eye
Homonomous Dominance	15.4	6.92	2.72	0.31
Right Eyed-Left Handed	8.8	16.2	18.5	5.6
Left Eyed-Right Handed	2.5	−3.1	−4.9	−1.3
Ambieyed	5.8	−1.25	5.0	4.0

TABLE IV

INCREMENTS IN VISUAL FIELDS AFTER TREATMENT

(In terms of degrees)

Classification	Horizontal Diameter		Vertical Diameter	
	Left Eye	Right Eye	Left Eye	Right Eye
Total number reexamined (26 cases)	9.9	5.8	9.5	6.7
Right Eyed (15 cases)	13.0	7.5	19.6	8.0
Left Eyed (7 cases)	3.4	7.5	5.7	7.1
Ambieyed (4 cases)	10.0	−2.5	1.6	0.0

Two of the cases showing no improvement presented mental deficiency.

There appears to be a relation between increment in the visual fields and improvement in school work.

Restricted fields are caused by diseases and injuries of the eyes, diseases in other parts of the body producing secondary field restriction, and poisons including toxins. Field restriction is disclosed by campimetric or perimetric studies. Diagnosis is made on the type of restriction, collateral symptoms and signs, and on the history. Prognosis depends on the underlying cause to which treatment must be directed. There is no specific treatment that can be applied indiscriminately to restricted fields. Each case requires individual treatment. Remedial educational measures may supplement the treatment and should take the form of drill in the recognition of larger and larger flashed units. At first the flash cards present short words of two or three letters. As drill progresses longer and longer words may be used and finally several words may be presented at once. Columns of figures may be used in the same way, the number of digits in the vertical column determining its length. Every case of restricted fields should be under the care of an eye doctor or general physician regardless of whether or not remedial drill is employed.

Isolated blind areas within the limits of the field, and changes in the physiological blind spot were expected but in the present series only one case presented anything of the kind. In this case the blind spot was enlarged to about 1½ times the normal size. Both eyes were similar. Ophthalmoscopic examination of the corresponding retinal areas revealed nothing of an abnormal or pathological nature. Further examination was negative and it was concluded that the condition was a physiological variation or individual difference.

SUMMARY

1. Reading physiology of the fovea centralis and retina are discussed.
2. Visual fields taken in eighty-five educational disability cases, forty unselected cases, and twelve "Normal" cases are compared.
3. The fields are considered in relation to lateral dominance.
4. Twenty-six educational disability cases were reexamined after a period of treatment and increments in their fields are reported. Improvement in their school work is also presented.
5. Remedial treatment is discussed.

CONCLUSIONS (PENDING FURTHER INVESTIGATION)

1. Educational disability cases present *smaller* fields than "Normal" or unselected cases.
2. Unselected cases present smaller fields than the "Normal" cases.
3. There is a tendency for differences to be greater among left eyes.
4. Among the left eyed-right handed there is a tendency for the fields to be larger in the educational disability group.
5. Restricted fields can be increased in size by treatment directed to the underlying causes.
6. The greater increase in field following treatment is in the non-dominant eye.
7. There is a relation between increment in visual fields and improvement in school work.

READING INVESTIGATIONS AT TEACHERS COLLEGE

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THIS paper will deal with reading investigations completed, under way, or shortly to be undertaken at Teachers College. It will refer briefly to studies undertaken since January 1, 1934, at which time officers of the local Civil Works Administration agreed to provide various amounts of assistance. Some of these projects were supported primarily by the Director of the New York City school system division of the relief projects, Mr. George H. Chatfield, Director of Attendance and Child Welfare of the New York City schools. Due to the fact that he had long been convinced that a large proportion of the cases of truancy, delinquency, and school maladjustments were the results of a frustration produced by inability to learn to read well, Mr. Chatfield responded heartily to the proposal made by one of the present writers that a city-wide remedial project be operated with relief workers and that a group of specialists be provided for studying some of the fundamental problems involved in reading difficulty. Beginning on January 1, 1934, Mr. Chatfield and his colleagues completed arrangements for providing 500 teachers, and 25 specialists to serve as directors and supervisors. Mr. Gates was extended the privilege of selecting the technical workers and supervisors and of working out the plan of procedure. A simple plan of diagnostic and remedial work was developed and explained to the supervisors during several oral sessions. Each of these supervisors in turn instructed the 20 to 28 teachers delegated to work in his or her district in the methods to be pursued. This period of training was very short for the teachers, who although qualified for teaching in the elementary grades, had had no previous instruction in diagnostic and remedial methods. The remedial instruction, for the most part, was conducted with pupils one at a time in periods of from 30 to 50 minutes daily. The pupils selected for instruction during the first term were numbered approximately 4000 and represented the most serious cases of disability in the New York City schools. Approximately 18,000 children, believed to be special disabilities in reading, were nominated for remedial work by the principals of the schools in New York City. The writers have nearly completed the analysis of the data obtained concerning approximately 2800 of the pupils tutored during the first semester. Some of the significant data are as follows:

The average chronological age was 109.3 months, and the average I.Q. 87.1. Twelve percent of the pupils had I.Q.'s of less than 75. Those pupils who had had between 18 and 22 days or a median of 30 days of coaching, showed an average gain of .56 of a grade in combination of silent and oral reading tests. Those who had had an average of 40 days coaching gained .64 of a grade; and those with a median of 50 periods gained .771 in reading. Since the average I.Q. of these pupils was about 87, the normal gain for 40 days for approximately 2 months work, for example, would be 1.75 months; whereas their gain under remedial instruction during this period was 7.68 months or over four times as much. Of those pupils who had had 30 days or more of instruction, only about 5 percent failed to show a gain of more than 1.75 months in reading ability. It may be said, therefore, that despite the fact that these were the most serious cases found in the New York City system, that many of them were very badly discouraged children (16 percent of the boys and 4 percent of the girls were already definitely problem cases), and the fact that the teachers had had little previous training and often far from adequate material, an attack upon the individual pupil's problems and specifically applied remedial instruction gave evidence of leading promptly to a solution of the reading difficulty in all but about 5 percent. This percentage probably represents for the most part types of problems that require more expert and detailed diagnosis than could be provided under these circumstances.

It is believed that it is fair to say that the widespread recognition of the help given by the project during the first semester has been responsible for the approval of the continuation of the project since that time. During the first term, Dr. Annette Bennett was nominated as technical director of the project, in which capacity she is still serving. At the present time more than 500 remedial teachers are engaged, and others are being added. Approximately 12,000 pupils have either been given remedial instruction or are now receiving it. The work has been carried out in such a way as to yield information on a number of problems associated with reading disability. Data on the frequency of various sorts of constitutional handicaps, foreign language background, intelligence, schoolroom facilities, and the like, have been obtained. Comparisons have been made of different types of remedial instruction, indicating that there is no one formal scheme suitable to all pupils. The best type of remedial instruction is one in which the materials and methods are nicely adjusted to the needs of each individual child and modified in accordance with the pupil's progress

under instruction. Comparisons of the results obtained by handling the pupils one at a time and in groups in various sizes are also being made. A detailed report of the results obtained in the first year will be made shortly by the present writers, and later reports will be presented by Dr. Bennett.

During the first term of the work, arrangements were made for four special studies for a small sampling of the types of pupils recommended for remedial instruction. One of these, an analysis of the auditory factors related to reading disability comprised the doctor's dissertation of Dr. Guy Bond.[1] This study shows that deficiencies in hearing as revealed by the Audiometer and in phonetic aptitude, as revealed by a series of tests, would tend to get pupils into difficulty in schools in which oral instruction, oral reading, and phonetic practices played a large role, and that hearing defect much less commonly produced difficulty in schools in which the method was relatively less oral. The study indicated also that failure to recognize hearing weakness and making an adjustment to it, as when a pupil with a hearing loss was seated in the back of the room near a noisy window, was very likely to lead to more or less serious difficulty.

A companion study, made upon the same population by Dr. Paul R. Fendrick,[2] was concerned with the visual aspects of the reading problem cases. Dr. Fendrick found that defects in visual acuity and clearness of perception appeared more frequently among the reading defects than among normal readers of similar age, intelligence, amount of schooling, etc. In his study also, it appeared that children with these defects learned to read when the limitation was noted and account taken of it. Thus, the pupil with weak vision might in some cases be insured a good start in reading by provision of lenses or better classroom location and a careful choice of large-type reading matter.

A third study, based upon the same group of pupils, conducted by Miss Jeannette McClure, was concerned with the personality and previous history of the reading problems in comparison with a control group. This study, now under way, will be offered as a doctor's dissertation.

A fourth study is concerned with various other constitutional factors, such as hand and eye dominance, and was made on the same pupils by

[1] Bond, Guy L. *The Auditory and Speech Characteristics of Poor Readers.* Teachers College Contributions to Education, No. 657. Bureau of Publications, Teachers College, Columbia University, 1935.

[2] Fendrick, Paul R., Jr. *Visual Characteristics of Poor Readers.* Contributions to Education, No. 656, Teachers College, Columbia University, 1935.

Mr. Gates. He also will report upon the interrelations of various types of defective techniques and other factors among normal pupils and among the reading defects.

As a result of evidence of certain subordinate studies made in connection with the remedial project during the first year that teaching the reading disability resulted in marked improvement in conduct and social adjustments, both in and out of school, several related investigations have been undertaken. In one of these, conducted by Drs. Bond and Fendrick, a group of delinquent boys at the House of Refuge at Randalls Island, was examined with mental and achievement tests. It was found that when this group was limited to those having I.Q.'s between 90 and 110 on the Stanford-Binet test, a reading retardation of 5 years and 2 months was found. While there were a number in the group who could read in a laborious translation-like process, there were scarcely any who could read intelligently.

Recognizing the fact that physiological or other deficiencies which may have operated at the time the pupil began to learn to read and which produced the reading defect may have been outgrown or otherwise removed before the time when these pupils are examined two or three years later, studies were begun in September, 1934 upon groups of children as they entered school. These pupils were given nearly 100 measurements, examinations, and observations of such characteristics as auditory and visual acuity and perception, intelligence, speaking fluency, ability to answer questions or complete stories orally, handedness, eye dominance, achievements in various reading readiness tests, and nearly all the other characteristics which have been suggested as a factor in reading readiness. Nearly all the examinations were given at the beginning, middle, and end of the school year, during which observations and records of the pupil's success in learning to read were kept. Many of the same examinations are being repeated during the current year and the pupil's further progress in reading noted. The results thus far obtained, which will be reported in a monograph, include, among other findings, the suggestions that although there is some degree of correlation of progress in learning to read and intelligence, there is no evidence that any specific mental age status may be regarded as an optimum time for beginning to read, nor that children below a particular mental age fail in relatively large proportions. Although a number of pupils in the group reveal visual defects, there was little evidence that such limitations were prominent factors in the causes

of failure. Indeed, this may be said to be true of substantially all of the constitutional factors including hand and eye dominance. The causes of failure seem more commonly to be due to the inability of the teacher to keep in close daily contact with the pupil's learning problems. Failures to understand a particular assignment or to learn a group of words or to acquire certain basal techniques, such as the left to right eye movement in studying an individual word, accidental factors resulting in an unfavorable classroom situation, and other such conditions, which better knowledge of the pupils and more detailed information about their daily successes and failures would have removed. Supporting this point of view was the fact that all children who, after about six months in school, had failed to get a good start in learning to read, were successfully taught in from three to four weeks by a remedial teacher, presumably no more expert than the regular classroom teacher, when she was given information about the pupils and an opportunity to coach them individually. In general, the results of this study indicate that recent claims that physiological immaturity as in the case of vision, hearing, motor control, and the like, tend to offer nearly insurmountable obstacles to learning to read, have been greatly over-estimated. The results also indicate that the assumption that the whole problem of reading defect may be largely solved merely by waiting for a favorable time at which to begin, is a vast over-simplification of the facts. The evidence is that many specific factors may result in difficulty or failing to learn to read, and that these factors tend to be present when the pupil begins irrespective of the age or mental status, within certain limits, at least.

As suggested above, this study of the relationship of maturity and various traits to competence in reading will be pursued as long as sufficient pupils remain in the school to give reliable data. It is our purpose to measure the growth of competence and correlate such growth with success in school activities and in other respects over a period of years. We will thus determine more precisely the changes which occur in such factors as phonetic aptitude, auditory apprehension of word elements, visual deficiency in various respects, auditory acuity, general skill in learning in a school situation, ability to learn in a group situation, skill in learning with seat work materials, and the like.

While a study of the type just described reveals the relationship of success in reading to the initial status in various respects, as in intelligence—due to the fact that the population at the time of beginning gave

a range of mental ages from around four years to above eight years—more convincing data may be secured by starting whole groups of pupils at different periods of time after entering school. Such experiments will be begun in February, 1936, at which time one group will begin reading upon entering first grade, another group after spending one term in a non-reading program, and another group after two terms in such a program.

This study will be made possible by the establishment of the Speyer Experimental School, which will go into operation in February, 1936. This school is to be operated as a joint enterprise by members of the staff of the Advanced School of Teachers College, Department of Educational Research, and the New York City school system. It will be set up as a separate experimental school under the general direction of Dr. Stephen F. Bayne, Associate Superintendent in charge of elementary schools, and under the more immediate supervision of Benjamin Greenberg, Assistant Superintendent, with a corps of New York City teachers and principals. The institution will be devoted primarily to the study of dull-normal children—I.Q.'s from 70-95 and superior children with I.Q.'s above 130. During the present term preparations have been made for certain studies to be conducted in this school.

The first study will consist in an intensive study of all pupils in the school subject to any degree of reading deficiency. It is expected that various officers of Teachers College and the New York City school system will coöperate in providing examinations for all types of constitutional and other difficulties which might be a factor in producing the reading defect. Special types of remedial materials and methods now nearing completion will be used in the remedial work.

Another, but closely related study will consist in the comparison of different organizations of material for teaching reading to pupils in the first three grades. For these classes from five to ten times as much reading matter written within the limits of the vocabulary introduced at a particular point will be provided and compared with other programs having smaller amounts of additional reading free from previously unstudied words. Certain new organizations of content for developing independent word recognition and the apprehension of words in thought units, etc., will also be tried out.

Another series of studies will be concerned with the relationship between various reading levels revealed by standardized tests and the pupil's capacity to learn from typical textbooks in arithmetic, history,

geography, grammar, and the like. In connection with this study, an analysis is being made of the distribution of a pupil's reading vocabulary in terms of levels in the Thorndike Word List. It is expected that new organizations of content will be developed for studying the relative suitability of different types of composition to the needs of pupils of different mental ages and reading ages.

Since it has been frequently suggested that dull-normal pupils, in particular, and perhaps all others, may learn many things more quickly and fully through other media, such as motion pictures, sound motion pictures, detailed oral presentation, oral presentation combined with pictures and graphic devices, oral presentation combined with demonstration apparatus, etc., a number of studies are planned for comparing the results of the uses of these devices with each other and with reading in a typical school situation. The first studies in this series will consist in comparison of different types of reading materials with each other and with several types of oral presentation by the teacher. Certain experiments will also be made in which sound motion picture materials will be used.

In addition to conducting a number of studies upon the relative merits of various types of materials and methods, it is planned to develop several types of curricula and to introduce them for comparative purposes into the program of the Speyer School for the dull-normal groups. A group of persons, including members of the staff of Teachers College and officers of the New York City system, will work together in developing these programs. They will probably vary from a program corresponding closely to the conventional organization utilizing reading of textbooks and recitations and discussional periods as the major component, to another extreme in which various activities with much less dependence upon formal reading of books or classroom teaching of conventional subject matter and a larger amount of constructive, exploratory, dramatic, linguistic, artistic, and other activities are included.

EXPERIMENTAL PROCEDURES IN THE STUDY OF THE PROCESS OF WORD DISCRIMINATION IN READING

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THE diagnostic tests applied to "reading disability" cases usually devote a large section to an attempt to discover under just what conditions the individual confuses or fails to recognize words. There is, however, confusion in the terminology used to describe these situations as well as considerable variation in the techniques employed. This is an attempt to introduce order and logical consistency into that terminology and, by a critical examination of the validity of the techniques already employed, to pave the way for more adequate research in the field.

TERMINOLOGY AND CLASSIFICATION OF ERRORS

A general summary of the error types or types of confusions in word discrimination into which data have been analyzed by various investigators can be most conveniently given in tabular form. The error types into which the data of nine representative investigations of reading were analyzed are given in the following tabulation:

Investigator	Subjects	Disorientation	Cues
		Disability Cases	
Orton 1925-1929	Grade 2 and above	Single letters Sequence: Word wholes Word parts	
Monroe 1928-1932	Grade 2 and above	"Reversals" Letters Letters in words Sequence	"Additions" "Omissions"
Gates 1933	Grade 2 and above	"Reversal of letters" "Reversal of parts"	"Same beginning, different end" "Same end, different beginning" "Same configuration, different letters"
		Normal Readers	
Payne 1930	Grades 2 to 5	Sequence confusions	Prominent single items Confusion between similarly shaped letters

Investigator	Subjects	Disorientation	Cues
		Beginning Reading Level	
Teegarden 1931	Kindergarten	Single letters and forms	
Smith 1928	First grade	Four reversible letters (*p*, *b*, *d*, *q*) hardest to match	Influence of position of hard letters on matching beginning, end, beginning and end
Davidson 1931	Preschoolers*	Sequence (Letter disorientations disregarded)	"Geometrical shape" Identical parts Single prominent elements
		Beginning Reading Level	
Gates and Boeker 1925	Kindergarten		Length Single prominent elements
Meek 1925	Kindergarten	(Letter disorientations disregarded)	"Initial letter" "Final letter" "Middle two letters" "Initial two letters" "Final two letters"

It will be noted that Orton (13), Monroe (9,10), and Gates (4) worked on disability cases beyond the beginning level, that Payne (14, 15) used normal readers also beyond the beginning level, and that the last group consists of investigators at the beginning reading level. The categories are tabulated for the most part according to the descriptions used by the original experimenters. Some need only a careful and explicit definition, but others need reconsideration on a more logical basis.

The term "reversal" will be found in the literature designating all directions of mirror imaging or directional disorientation in single letters and all kinds of sequence errors. However, it seems often to carry the connotation of transverse or horizontal mirror imaging only. The term "disorientation" is recommended as more accurately descriptive of the phenomenon of mirror imaging. The possible directions which the disorientation may take can best be described by the simple directional

*Mental age, 4 years; chronological age 3, 4, and 5 years.

terms: horizontal, vertical, and diagonal. A *b* mistaken for a *d* would be classified as a horizontal disorientation; confusion between *p* and *b* is a vertical disorientation; and the *p-d* pair illustrates the diagonal disorientation. The term disorientation then applies to perceptual confusions of a unit according to the various spatial directions in which it might be viewed in a mirror. *P*, *b*, *d*, *q*, *u*, and *n* are the six letters which might cause confusion when disorjented. An *a*, *g*, or *c* might cause some slight confusion when disoriented because of the unfamiliarity of the disoriented symbol, but in all probability would not be mistaken for any other letter as in the case of the six mentioned above.

This places a certain limitation on the use of the term disorientation. This limitation follows as a logical carrying out of Orton's (11, 12) theory of the causation of mirror image difficulties. He postulates pairs of engrams in the cortex which are mirror images of each other. If cerebral dominance is not very decided, the two images will compete for precedence. The classification of the single letter disorientations discussed above under this head is then correct, but before placing all sequence difficulties here their nature must also be analyzed. In order to classify the error *was* read as *saw* (the classic example) as a mirror image confusion, we must assume that the child has actually seen the *s* turned about first, then the *a* also turned about, and finally the *w*, which would look the same even though horizontally disoriented. The child then has recognized the individual letters in spite of their disorientation but has read them in reversed order.

If a letter which when disoriented appears to be another letter is included in a sequence error and yet the disoriented form is not utilized by the child, the fault can scarcely be included under sequence errors. An example should make this clear. If the error *dog* read as *god* is classified as a horizontal disorientation, the assumption has been that the wrong engram gained precedence, that is, the engram that contained each letter reversed as well as the letters in reversed order as described above. In this case if that had really occurred, the *d* would have appeared to the child as a *b*. If the word is not read that way (gob), the error must be put down to some such difficulty as faulty eye movements rather than to disorientation in the strict sense of the term as defined above. A better term for this type of error which cannot be assumed to involve a disorientation of the letters themselves would be "mixed order."

The term "cues" has been popular in the literature and seems a useful one. It has been used to designate the use of a particular part or aspect

of a word as a means of recognition. Adequate and inadequate cues are spoken of. The term is used in the preceding tabulation to designate those situations which put their emphasis upon the identical parts of words. Since the rest of these words is varied, the identical part is the cue being tested for. References to prominent elements in words and outstanding details have also occurred frequently. Such references are included under "cues" in the tabulation since, strictly speaking, the detail is a cue although frequently of a particularly complicated sort.

"Configuration" is a term used by Gates (4) in his error analysis. Davidson's (2) term "geometrical shape" has the same meaning and is a fairly adequate definition of the other term. Tall letters, long letters, and short letters are the factors making up the geometrical form of a word. It is one aspect of a whole word and, therefore, may be called a cue. It may be held constant while other factors in the word are varied, or it may be varied along with certain other aspects of the word.

CRITICAL SUMMARY OF EXPERIMENTS

Orton's (13) work on which Monroe's is based concerns itself entirely with reversal or disorientation difficulties. However, thoroughly as he has gone into the neurology and physiology of the problem, Orton groups all directions of disorientation and all degrees and kinds of sequence confusions together. He does not give experimental evidence of their general or relative incidence throughout the range of reading abilities.

The Monroe Diagnostic Reading Examination (10) consists of visual responses to auditory stimuli and verbal responses to visual stimuli rather than any direct visual discriminations. However, there are certain categories in the analysis of errors which have a distinct bearing on the discriminative functions. These are "reversal" errors of various types, "additions," and "omissions." Monroe does not consider word parts as cues since all other error types are phonetic classifications, such as "faulty vowels" and "faulty consonants." These quite disregard the position of the error in the word and its similarity to some possible confusing word.

Gates (4) used tests which are of a more truly discriminative character, with rather more completely described error categories. This in turn necessitated a more controlled testing vehicle. He allows his five error categories to compete against each other in a visual-recognition multiple-choice situation. The analytical score must then be based upon the assumption that if a child makes a certain error, for instance chooses the letter combination *baes* for the word *dear*, the occurrence is due to the

use of the inadequate cue or to the confusion type under which this error is listed. In the case cited the error is classified as "same configuration, different letters." To make such a conclusion valid (and it is the conclusion that is of major interest in this type of analysis), all other causes of error must be eliminated so far as possible. This, unfortunately, is not the case in a rather considerable number of Gates' test items. In the error already mentioned, *b* is a horizontal disorientation of *d* and occurs in the corresponding position in the error. Also the middle two letters of *baes* are identical with the middle two of *dear* but are reversed in sequence. In this case then we cannot be sure that the error is exclusively due to the influence of the similar configuration existing between the two words.

There are enough items of this imperfectly controlled type in this test to invalidate considerably any specific conclusions as to what is really causing the error. It may very well distinguish poor from good readers and even yield valid clues for retraining the defects found, but a statement of the specific influences operating to cause the difficulty is not possible from a test constructed in this partially controlled manner.

There are two more major objections to the adequacy of this test in supplying valid results of the type desired. One of these objections is also applicable to Monroe's tests and to the work of many other investigators, namely, the use of meaningful material. The extent of training on individual words varies from child to child even at the earliest levels. This variation may affect the individual's performance in practically any sampling of words. The other objection is that there is no guarantee in the technique (other than the instructions to the subject and watchfulness of the examiner) that all the letter combinations in the rows of five or six will be looked at with equal attention. Thus the error categories are not competing on an equal basis.

Taking all these criticisms into consideration, a specific analysis of the data from such tests cannot be valid. We cannot be sure whether configuration itself is a confusing factor of some magnitude or whether it only causes errors when in combination with other confusing factors; whether the first or last or middle parts of words are really more potent in causing errors or more used as cues in discrimination; or what the real strength of disoriented letters and sequence is in the confusions which occur.

Payne (14) also used meaningful material. However, some of the material was purposely of such a nature that the subjects were not familiar

with it. This enabled her to get more accurately at the influences operating in quick recognition or reading of words. She used a tachistoscopic technique with this pertinent result: When the meaning of a word is unknown or when the word is incompletely seen, a similar looking or sounding word will be substituted. This result is undoubtedly due to the fact that the subject's *aufgabe* was that of meaningful material. In the case of the incompletely seen words, however, she found that certain letters had an especial prominence and were used as cues to a whole word, sometimes causing mixed sequence; that there was confusion between letters of similar shape; and that there was an occasional reversal of whole words or parts of words.

In the group of experimenters who worked at the beginning level or below, Teegarden (17) worked only with disorientation and within this field only with single letters presented in isolation. She tells nothing of the difficulties presented by such items when included in words or of total or partial word disorientation.

Smith (16) had first graders just starting to read match the letters of the alphabet. She found that the four reversible letters *p*, *b*, *d*, and *q* were the most difficult to match as determined by incidence of error, while *u* and *n* fell in the next most difficult group. Such letters as *a*, *o*, and *g* that could be easily distinguished in whatever orientation they appeared were the easiest to match. The four most difficult letters were also placed in nonsense words of three letters for matching and the influence of the position in the word of the difficult letter noted. This is the most controlled study of the group but covers only a small portion of the field.

Davidson (2) did a learning experiment on reading at the beginning level. Since meaningful material was necessarily used and no sort of control was exercised over the material used for analysis, the errors pile up almost inextricably. Her analysis is not very concise and is quite subjective in classification, so that one can only judge roughly of the relative importance of the errors found to occur. There is, however, much material suggestive of the types of error that may be expected to occur.

Gates and Boeker (5) gave word lists of ten words each to be learned. The length of word was held constant within any one list but the group of lists included words of from three through ten letters. The words within any one list were not selected systematically except for length. Therefore, the particular confusions causing trouble cannot be analyzed out specifically, although the authors conclude that "small but outstanding" details of words such as the dot over the *i* in *pig* and the "funny

cross" in *box* were used as cues. A list of words varying in length was also given, and here the length of word was used as a criterion for discrimination in learning.

Meek's investigation (8) was also a study of learning but she used only six words. The learning involved was a discrimination between the words to be learned and five other words whose relationship to the correct one was partially controlled. Unfortunately for the value of the study in choosing these words, she took account only of the actual letters in the positions being studied and disregarded the possible confusions which might result from disorientations and similar configurations. She especially remarks upon the great difficulty her subjects experienced in distinguishing between *bill* and *doll*. The confusion is classified as "final two" letters identical, and she disregards the fact that the initial letters are different orientations of the same form and that the configurations of the two words are identical. This type of incompleteness in her error analysis must somewhat invalidate her conclusions. For instance, the weight which she gives to the influence of the final part of the word must be considerably discounted, as is shown by this example.

An experimental study by Levin (7), unfortunately not announced in English until after completion of the present manuscript and not yet available in complete form, seems to have made an attack upon the field from the very completely and carefully analytical point of view advocated here. The significance of the form of letters and the position of constituent elements are studied in nonsense material together with less direct aspects of perception. The level of reading ability or experience at which the experiment was performed, however, is not reported, nor are results quoted in the available abstract of the study.

It might be well at this point to mention the work that has been done on reading readiness. These tests do not pretend to give an analytical account of the error incidence, but the types of error which they allow for in their discrimination tests are of interest. They follow closely the types described in the studies discussed above. Among the possibilities of error, both Van Wagenen (18) and Deputy (3) place words of similar configuration, words containing identical elements in various positions in the word, occasionally words of the same length only, and words representative of the addition and omission categories. The Ingraham-Clark diagnostic reading test (6) is an achievement test for the first grade which yields an analytical score for use in drawing up individual profiles of the various

abilities tested, such as various kinds of memory, comprehension, discrimination, etc. Within the discrimination tests, for which only a gross score is given, the same kinds of confusions as those mentioned above are allowed to operate.

GENERAL CRITIQUE OF EXPERIMENTAL APPROACH

In educational research a common procedure which might seem to be appropriate to the problem under consideration has been to observe and report errors occurring in regular usage. Thus Charters (1) in the *Sixteenth Yearbook* reports on "mistakes in the use of the capital," "mistakes in the use of the period," "mistakes in verbs," "lack of agreement between subject and verb," etc. These errors, generally speaking, are classifiable without question under a particular heading.

The situation in the investigation of reading errors is more complex. It is very seldom that a particular error occurring in an uncontrolled situation is definitely classifiable in one error category. To classify each error under all possible categories will scarcely give a valid picture of the relative difficulty of certain situations. Therefore, most experimenters attempting analysis from uncontrolled situations resort to a more or less subjective classification of errors. An example of this is the error *house* read as *home* that is classified by Davidson (2) under confusions due to similarity in geometrical form. But she also has categories entitled "first two letters identical," "initial letter identical," "guesses," and "context confusions." Her judgment of this error as primarily due to geometrical form similarity would, in all probability, be severely questioned by others. *Party* read as *pretty* and *out* read as *cut* are also included in the geometrical forms category. Final letters identical and reversal of letter order are other categories that some might wish to utilize for these errors. *Boy* read as *yes* is classified as "word beginning with last letter of correct word," yet she makes a good deal of her "peculiar letter" category. These same types of difficulty are experienced by veteran workers with the Monroe Diagnostic Tests. Seldom will two scorings agree absolutely. Here, however, there are so many test items present that the gross scores are not affected enough to change the picture materially. Nevertheless the error is there. The validity of the conclusions for finer analysis is reduced.

An approach of this type, moreover, was attempted in an experiment conducted by the author, and its futility for the type of detailed and exact results desired was thoroughly demonstrated by problems such as those quoted from Davidson's study. Undoubtedly, in many cases the errors

are due to a combination of factors operating; but the discovery, from such a situation, of the exact components of those combinations and the most potent ones is often difficult.

An experimental set-up should be possible in the light of such an examination of other research as that presented here in which there would be purity of testing at least to the extent that the factors possibly operating to cause confusion were known even if not always controlled. With a fairly complete sampling of the types of situations most apt to be met in reading, much of the confusion in results due to inadequacies in the techniques could be cleared away.

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EDITORIALS

RESEARCH IN READING

In recent months the *Journal of Educational Research* has received a number of reports of highly significant research in the field of reading. In this issue there is included together with Dr. Gray's annual summary of research in reading a series of articles dealing with the study of various factors that contribute to reading disability. They describe investigations from the first grade level to the college level. They deal largely with attempts to get at causative factors of the physiological type. It is interesting to note that these studies reveal that there is not a single factor that is invariably operative and that such factors as may be crucial appear in different combinations that vary from individual to individual. The study of Drs. Swanson and Tiffin show the high degree of adaptability of the human organism in overcoming visual handicaps that interfere with learning. The results of their study together with the conclusions arrived at by Witty suggest the need of caution in any plan of reading guidance, especially in the primary grades, based on the results of the Betts tests. It seems clear that many persons learn to read with considerable facility even though they have physiological handicaps to overcome. All should at least be given the chance to learn even if tests may reveal minor physical limitations.

In this number is also included a report of research in reading under way or completed in one of our leading universities. It suggests trends of research in reading. It is planned to follow this number with another on reading, and with others of a similar kind in various fields, such as arithmetic, social studies, and the like. Contributions to these will be welcomed by the Editorial Board.

LEO J. BRUECKNER

NEED OF COÖPERATION BETWEEN LABORATORY AND CLASSROOM

A survey of the scientific literature relating to reading supplies striking evidence of the tremendous progress which has been made during the last quarter of a century. From a total of less than fifty published studies in 1910 the number has increased to approximately fifteen hundred today. Whereas less than ten studies were published in 1910 more than one hundred ten appeared during the period from July 1, 1934 to June 30, 1935.

Even more important than the increase in the number of studies published are facts relating to their quality and to the scope of the problems investigated. A casual comparison of the earlier and the later studies supplies striking evidence of the general superiority of those published recently. They are better planned, more rigidly controlled, and the results are interpreted more broadly and with greater discrimination. However, the importance of further progress in these directions cannot be overemphasized.

Paralleling the improvement in the quality of the studies reported notable progress has been made in the scope of the problems investigated. Whereas prior to 1910 the studies reported related largely to the nature of eye movements in reading, the perceptual processes involved in reading, and the reading interests of children, the studies published during the past few years have been concerned with a surprisingly wide range of issues. Of special significance in this connection is the fact that investigators have become intensely interested in reading problems at the secondary school and college levels and in adult life in general. As a result of this general trend the field of reading is now very comprehensive and embraces a surprisingly wide range of problems.

The scientific work which has been done thus far is not free from criticisms. Unfortunately many objective studies which have been published recently have not been carefully planned, have involved few if any controls, and the findings have been loosely interpreted. Furthermore, there is inadequate concentration on specific problems to insure reliable and complete solutions of the issues involved. Most of the studies published include the statement that the conclusions are tentative and that

additional research is essential. Only rarely, however, does the investigator continue his work on the problem.

Unfortunately, opportunism plays too large a part in the selection of the problems studied. We are all prone to direct our energies along lines which will make a popular appeal at the moment. As a result, there is urgent need for such reorganization of research activities as will insure the continuous study of specific problems until all the major issues involved have been carefully investigated and abundant evidence secured to justify conclusions.

One of the impressive lessons which has been taught through recent scientific study of reading problems is that closer coöperation is essential between the laboratory and the classroom. The fact is well known that classroom practice lags far behind current knowledge of valid procedures. As investigation continues there should be closer coöperation between investigators, school officers, and teachers. The mutual responsibilities of each have already been clearly defined: "The scientist must continue his laboratory studies, discover fundamental differences in reading processes and habits, outline the principles which determine effective methods of teaching, and develop methods of investigation which can be used in the classroom. Administrators must provide agencies for dealing effectively with the mental processes and habits discovered in the laboratory, for applying the instruments of investigation which are available, for checking the results of teaching, and for discovering additional problems for study and investigation. Teachers must be zealous students of reading problems, must apply the results of scientific studies in improving and refining their technique of teaching, and must make use of scientific methods in the daily study of classroom problems. Only through continuous and whole-hearted coöperation on the part of all the agencies interested in reading problems can we hope to attain an adequate solution of both the theoretical and the practical issues involved."

WILLIAM S. GRAY

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